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READABILITY AND THE PRODUCTION OF INSTRUCTIONAL TEXT IN THE ROY--ETC(U)
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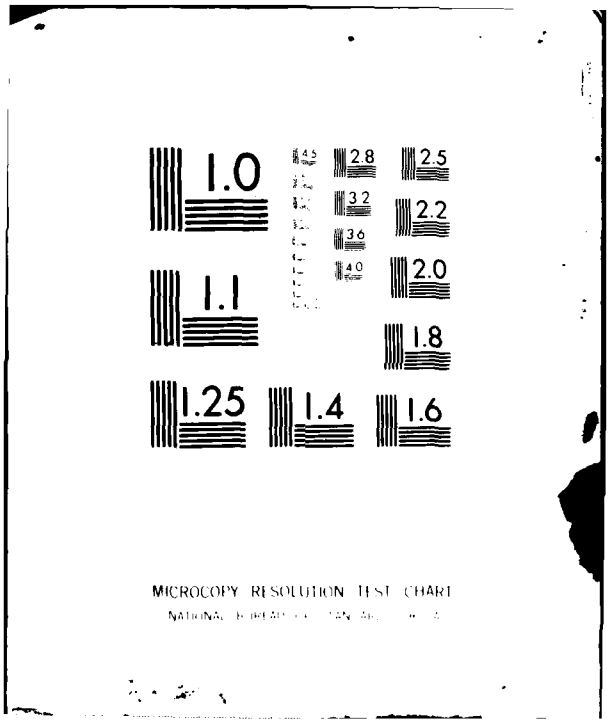
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(6) READABILITY AND THE PRODUCTION OF INSTRUCTIONAL TEXT IN THE ROYAL NAVY

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Summary

This report is an examination of readability and the production of instructional text in the Royal Navy. After defining readability, the history and reasons for development of the subject are outlined. The results of a survey to assess knowledge of the subject in Royal Navy training establishments are reported. The nature of reading and factors affecting comprehension are considered, and methods of assessing readability are examined in detail.

It is proposed that the present methods of writing and designing instructional text in the Royal Navy could be improved. However, it is recognised that there is no single best method of writing and measuring the effectiveness of text.

A compromise solution is recommended, involving the adoption of a general but systematic approach. This could be implemented by the development of a practical course and guide based on research findings for improving written communication.

A review of guidelines for the production of instructional text based on empirical research is presented in Appendix F.

An outline of a proposed writer's production checklist or job aid is presented in Appendix G. (U).

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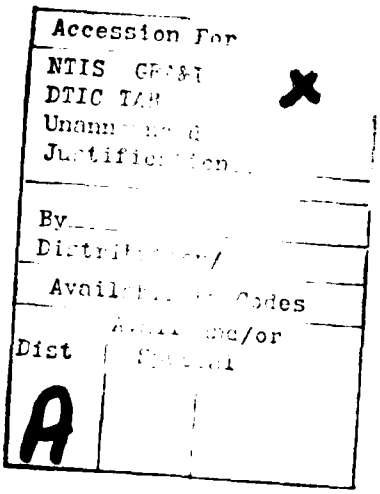

INTRODUCTION

"Everything that can be said, can be said clearly".

Wittgenstein L.
Tracatus Logico - Philosophicus 4.116 (1922)

(a) Readability Defined

Reading is a complex process which depends on many interesting variables in the reader, the text and the environment. As Tinker [60] wrote "It involves skill in word recognition, increase in vocabulary, knowledge of concepts, and enlarging ability to comprehend ideas". Both legibility and meaning are therefore involved. The process is further complicated by the highly personal nature of meaning, and by the tendency for readers to perceive what they want to perceive.

The expression Readability was adopted around 1940 to account for the study of reading factors which include both legibility and content of a piece of written text. The subject is concerned with the problem of matching a collection of individuals, with given reading skills and interests, to reading material which can vary widely in content, style and complexity.

Dale and Chall [20] defined readability as "the sum total - including interactions - of all those elements within a piece of printed material that affects the success that a group of readers have with it." They further defined success as "the extent to which readers understand it, read it at optimum speed, and find it interesting." This definition stresses three aspects of the reading process: comprehension, fluency and interest.

Comprehension is concerned with the meaning which can be attached to the print. The main emphasis of this aspect is upon the elements which lead to comprehension - the understanding of words and phrases, and the relating of ideas to experience. It is also dependent upon the fluency and interest of the text.

Fluency is the extent to which a given text can be read at optimum speed. This aspect emphasises the perceptual skills of reading, that is, the ease with which a text may be seen and words identified.

Interest refers to the motivational factors which readers have.

Dale and Chall [20] suggested that these elements in the definition are not separate; they interact to affect readability. The three elements isolated in this definition, together with the additional effects of interaction, are a source of difficulty and misunderstanding in many studies of readability. The elements are different and bear little relationship to one another, yet they have often been collected together and treated as equal in single statements. When measures which are supposed to reflect this

definition of readability are considered, shortcomings are obvious. Such measures often involve only one of the elements of the definition, and create a problem in that the results of different readability measures may not be properly compared.

English and English [23] defined readability as "the quality of a written communication that makes it easy for a given class of persons to understand its meaning, or that induces them to continue reading". This does not draw attention to all the components of readability as does the Dale and Chall [20] definition. However, it is useful in its emphasis on the text and its properties rather than the reader. It draws attention to the fact that readability is complex, and that its components must be analysed separately as well as in combination.

Klare [35] identified three criteria for readability. These are the need for:

Legibility of type and design
Ease of reading because of interest value
Ease of understanding or comprehension due to writing style.

All of the definitions and criteria cited are useful, but a complete explanation is difficult to achieve. It is one thing to read; it is another to understand; and it is yet another to understand easily.

(b) The History of Readability

There is evidence of a long and sustained interest in assessing the effectiveness of the spoken word. Supporters of the need for clear speech have quoted St Paul (1 Corinthians 14 : 9) "Except ye utter by the tongue words easy to be understood, how shall it be known what is spoken?"

Lorge [41] explained how the Talmudists - about 900 AD - in compiling and studying the body of laws called the Talmud, counted the occurrences of words and ideas in trying to distinguish differences in meaning. It is not surprising that evidence of an interest in clear speech and readability of text should come from religious writings. Religious orders were the most literate - and often the only literate persons - in a community. They were, of necessity, much concerned with the communication of ideas. Just as the need for effective communication was recognised by speakers, so the desirability of ensuring a close match between readers and text through various forms of systematic assessment has been recognised for some time.

Educators understandably showed an interest in readability. Klare [35] reported cases of educationalists in the 19th century who related counts of vocabulary and familiar words to reading difficulty. These investigations represent the first objective attempts to appraise the difficulty of texts. From the beginning of the 20th century the study of readability has been concerned with the search for elements in the text which may be easily counted

and incorporated into objective measures. Such measures have usually taken the form of a formula, and procedures have often involved long calculations. Formulae which have provided the most common measures of readability have shown certain stages of development. These reflect the aims and intentions of the designers, and also changes in the demands of people using the formulae.

Klare [35] described the chronological sequence in the growth of formulae, and identified four main stages:

(1) An early series of formulae were produced between 1920 and 1934. Although crude and clumsy in operation, they did use elements of the text such as vocabulary range and the number of prepositions or polysyllabic words. These were refined to produce reliable measures of readability. Such early formulae were applied generally, and gave only approximate ratings of the difficulty of text.

(2) From 1934 to 1938 the formulae devised became more detailed, and reflected a concern for greater accuracy and reliability. Such measures involved the use of elements of the text, but they required laborious collection of statistics and long calculations.

(3) Between 1938 to 1953 detailed formulae were replaced by a series of formulae in which efficiency and simplicity of use were the main consideration. This change of emphasis reflected the practical requirements of teachers and other workers who were limited in time and effort available.

(4) The latest period in the development of formulae - as reported by Klare [35] - extended from 1953 to 1959. It showed a change of emphasis to the development of specialised formulae for particular purposes. Such formulae were devised to deal with the characteristics of particular types of reading material, such as technical writing or the level of abstractness of a passage.

More recently interest in readability has been revived as a result of an increase in the volume and variety of forms of printed material, and the strong demand for universal literacy. This has led to an increase in the need to search further for accurate and quick measures to help predict and control the difficulty of text. The possibility of using new methods of measurement such as charts, graphs, sentence completion and computer checks, have helped the revival. Recent studies in linguistics have added to the understanding of language and the part it plays in reading and comprehension. This has allowed a more coherent and theoretically-supported approach to the practical problems involved in measuring readability.

2. WHY THE ROYAL NAVY NEEDS TO CONSIDER READABILITY AND THE PRODUCTION OF INSTRUCTIONAL TEXT

Like most large organisations the Royal Navy produces vast quantities of written information for a wide variety of readers. The intention

of instructional text is that words printed on paper for operational or training purposes should be fully and easily understood. The assumptions that all trainees or students know how to read and study effectively, and that writers intuitively know best, is often not warranted.

It has frequently been found that written information is often difficult to follow, understand,and remember (Chapanis [15]). In a discussion of language and ergonomics Broadbent [10] pointed out that "the instructions for operating or maintaining a machine may be just as important for the user as the design of the machine itself". Engineering drawings, planning sheets, machine operating instructions and maintenance manuals are now more complex than ever. Yet even the most simple machine must have clearly-produced operating instructions. This is often not achieved. Chapanis [15] suggested that this may be because "Many people believe that difficult or obscure writing is the work of a learned man". Problems of written communication appear common. In 1977 President Carter called for United States' government publications to be made more understandable, and similar suggestions have been made in this country.

Hartley and Burnhill [28] commented that poor design of written information had been responsible for costly and dangerous mistakes. The clarity of instructional text is particularly important in a military context, where decision-making and safety are crucial.

An example of inadequate operating procedures is reported by Vandenberg [63]. The United States' Gemini 9 spacecraft failed to achieve one of its major objectives - attachment to a target vehicle. The connection proved impossible because "improperly-installed disconnect lanyards had not pulled a protective shroud away from the docking apparatus." This $900,000 failure occurred because "the written procedures used by technicians to ready the shroud were found to be insufficiently detailed to ensure proper installation of the lanyards attached to the shroud mechanism". Few shortcomings produce this kind of dramatic error, but the potential problems of written communication seem sufficiently widespread to justify a consideration of measures which might be taken to effect a general improvement.

Recent surveys in the United States' Armed Services have revealed growing concern among managers that their personnel have reading difficulties. Problems appear to be a joint function of the reading skill of personnel and the level of difficulty of the reading material. As Kniffen et al [39] commented, a 'literacy gap' is created which in turn has affected operational consequences. When attempting to define literacy requirements of various jobs in the United States' Army, Sticht [55] found that only 10% of textbooks were written at the appropriate reading level.

Rynn [52] carried out a readability analysis of British Army Notice Board Information Sheets. He found that 61% of his sample were unable to work on material without supervision; 33% were able to work material but required some help. Only 6% were able to work on material without

help. He commented that the literacy gap in organisations like the Army is wide, and that notice board information sheets are often "not written for the reader who consumes them, but for the writer who wrote them".

Crosby [19] carried out a readability analysis on a sample of electrical maintenance manuals used in the Royal Navy. He used the following 8 formulae:

Flesch Reading Index
Flesch Human Index
Farr-Jenkins-Patterson Reading Index
Fog Index
Smog Grade Level
Forcast Reading Grade Level
Mugford Difficulty Index
Dale and Chall Index.

He found that there was a mismatch between the reading difficulty of texts and the probable reading skill of the users. Material was described by formulae characteristics as 'dull', 'very difficult' and 'appropriate for a reading age of 18+.' This did not seem suitable for Junior Mechanics under initial training.

(a) Survey of Knowledge About and Methods Used for Producing Instructional Text in the Royal Navy

It was decided to make an exploratory survey to find out what is known about the subject of readability and the production of instructional text, and how text is currently produced. No particular hypothesis was generated.

Method:

1. Procedure:

A structured interview questionnaire was developed, based on knowledge acquired during the early stages of the project.

Personnel in training establishments were interviewed in a friendly, informal way. Notes were taken.

At the time of the interview subjects were not aware of the details of the study.

After the main points were covered, the purposes of the study were explained and discussed.

2. Subjects:

Contact was made with all the major educational and training establishments in the Royal Navy. The 4 major specialisations were covered: Seaman, Supply, Electrical, Engineering, and the Royal Marines and Women's Royal Naval Service. A list of the establishments surveyed is in Appendix A.

Personnel contacted were those concerned with the production or assessment of course material. They were of Lieutenant Commander, Lieutenant or First Officer WRNs rank, ie middle management level. Appointments varied in title: Course Design Officer, Training Design Officer, Training Officer, Training Support Officer, Assessment Officer, Quality Control Officer. 85% of those interviewed were of the Instructor Officer specialisation - the Royal Naval branch for education and training.

3. Design:

Structured interviews were used as in Appendix B. This method was chosen for two reasons. It was believed that richer data would be obtained than by a postal questionnaire. It was anticipated that some interpretation of the subject would be required.

4. Findings:

Question 1. In what format is instructional text written in your establishment?

Joint Services Publication
Traditional Royal Naval layout
Personal style
Civilian format according to purchased books.

Question 2. Who writes the instructional text used in your establishment?

Books of Reference: Naval Staff authors, Technical Writers.
Locally-produced notes/handouts: Specialist serving officers, senior rates and non-commissioned officers, civilian instructors.
Civilian publications: Civilian technical authors.

Question 3. What method is used for producing instructional text text in your establishment?

In $\frac{17}{22}$ - 77% of establishments an individual is given the job of writing text from instructional specifications.

Question 4. Do your writers work as individuals or teams?

In $\frac{17}{22}$ - 77% of establishments individuals write independently.

Question 5. Is your instructional text tested on probable readers before use?

In $\frac{21}{22}$ - 95% of establishments no testing is performed.

Question 6. Can you define the term Readability?

$\frac{20}{22}$ - 91% could not define the term Readability.

Question 7. Do you know about strategies available for writing and assessing the effective production of instructional text?

$\frac{22}{22}$ - 100% did not know anything about strategies available for writing and assessing the effective production of instructional text.

Question 8. Have your writers had any training the production of instructional text?

$\frac{21}{22}$ - 95% of writers had not had any training in the production of instructional text.

Question 9. Have you had any training in the production of instructional text?

$\frac{22}{22}$ - 100% of personnel contacted had not had any training in the production of instructional text.

Question 10. Has your establishment any problems with trainees' understanding of instructional text?

$\frac{16}{22}$ - 74% believed that their establishment had problems with trainees' understanding of instructional text.

(HMS CAMBRIDGE was visited during the survey, but it was found that instructional material is produced by parent establishment - HMS DRYAD).

5. Discussion of findings:

The findings show that many different types of instructional text are used by the Royal Navy, and a wide variety of writers is employed.

It appears that production of instructional text concentrates almost entirely on content and the identification and achievement of instructional specifications and objectives. This is based on the systems approach to training (Eckstrand [22]). However, while it is important to define behavioural objectives, it is also necessary to ensure that material chosen is communicated in the most effective way.

The survey suggests that apart from provision of objectives, conditions and standards, most production of text is written by individuals in a subjective and intuitive way. Content only may be checked by others. Checking of material often happens at the end of courses, but rarely is it tested before being used. It appears that there are considerable time constraints on the production of text, and many personnel have tr produce written material in their own time.

Examination of data shows that knowledge about readability and the effective production of instructional text is almost non-existent in the Royal Navy. This even applies to Instructor Officers, who are the Royal Naval specialists in education and training. There is no Service training available other than one 5-day Joint Services Technical Authorship course held at Bristol University each year. Yet a significant number of those interviewed suggested that there are problems in trainees' understanding of text. Most training problems are attributed to lack of time, poor quality of instructors or trainees. It appeared that many interviewees believed that instructional specifications were synonymous with effective production of text, and were not concerned with the means of communication. It was as well that this was foreseen as a problem, and a structured interview used rather than a postal questionnaire.

The survey indicated that although much is now known about readability and the effective production of instructional text, the Royal Navy is not applying such considerations in education and training. It was noticeable during the later stages of interviews how enthusiastic interviewees became when the subject and stragegies for improving the production of text were explained.

Examples of poorly-produced instructional text:

During the survey, samples of instructional text used in establishments were examined. Many faults were apparent such as:

Poor printing
Difficult words
Ambiguous words
Abbreviations without explanation
Long sentences and run-together format
Illogical sequencing
Too much detail on one diagram
Diagrams separated from text
Conflicting and contradictory instructions
Too much information given.

Some examples of such text are reproduced in Appendix C. This booklet BR 4007, Guide to Ship Firefighting, is intended to be read by all Royal Navy personnel.

It has not been chosen because it is the worst example, but because of its unclassified material and the fact that all ranks and ratings must understand its contents.

In addition to this survey in the Royal Naval training establishments, visits were made to organisations who are researching readability and the production of instructional text. A list of organisations and individuals visited is in Appendix D.

With apparently ever-reducing budgets the Fleet has to be operated by less men with shorter training. If ships and their

increasingly complex equipment are to be kept at a high level of effectiveness, then operators and maintainers will have to be provided with efficient training and job aids. As most aids are in the form of printed text, clearly there is a need to match text and user as closely as possible.

Specially designed and improved aids should be able to satisfy 3 main criteria:

> They should increase operational performance and effectiveness, including safety considerations.
>
> They should improve efficiency and productivity by enabling fewer, less well-trained men to perform more complex tasks quicker.
>
> They should enhance manpower utilisation by encouraging the novice to improve his level of knowledge and skill on the job independently. This could be achieved by presenting information in the optimum way: clearly, sequentially, and at appropriate levels of difficulty.

The production of effective instructional text is particularly important in an organisation like the Royal Navy, where a great deal of autonomy exists for those working at sea. In war-time the need for clear writing would be even greater, as the mobilisation of large numbers of personnel could be expected to produce an even wider 'literacy gap'. In spite of technological advances there is still a place for printed text. The medium is inexpensive and simple to produce, it is readily available, familiar, convenient and effective, it can be updated quickly and easily, and may be combined with other means of communication.

Given the current lack of information available to writers of instructional text in the Royal Navy, it is essential that methods of improving text should be considered. Even small changes in the presentation of training and operational material or instructions could bring about a significant increase in comprehension, performance and time-saving. Improvements in the production of written communication would also have implications for improving programmed instruction, cathode ray tube and visual display unit presentation.

3. THE READING ENVIRONMENT

An important yet often overlooked factor in reading and readability is the actual situation in which the text is to be used. This topic has been well researched, and findings provide useful guidelines.

The reading environment includes such considerations as the optimum position and distance of text from the reader, lighting, temperature, noise, vibration of text and motion of the reader. These all have implications for the writers of text, particularly when material is to be used at sea.

Tinker [61] found that the printed page was read most effectively when positioned on a plane perpendicular to the line of sight or visual axis. This plane is usually at about a 45° angle from a table or desk top. Tinker [61] found that a deviation of only 15% either way significantly interfered with easy and fast reading. In the same study Tinker [61] found that the best reading distance to reduce visual fatigue was between 10" to 18", preferably 14".

For effective reading, appropriate lighting is necessary. Tinker [60] suggested that inadequate lighting led to reduced reading speed, eye strain and visual fatigue,because small details were not sufficiently visible. The unit of measurement in determining lighting is the footcandle (fc) or footlambert (fl). This is defined as "the light intensity upon a surface perpendicular to the light rays from a standard candle at a distance of one foot". Today the expression lux is more common. 10 lux is the equivalent of 1 footcandle. Tinker [60] recommended that for normal-sized print the following scale should apply:

Casual reading	fc	15-20	lux	150-200
General reading		20-30		200-300
Sustained study		25-35		250-350
Detailed work and study		40-100		400-1000

Tinker [60] also reported that the control of light distribution was important. Loss of efficiency in reading may be caused by the unsatisfactory diffusion of light due to glare from highly polished or bright objects or lights within the field of vision. A review of the effects of brightness contrast led Tinker [60] to propose brightness ratios within which conditions for reading are satisfactory. The term 'brightness ratio' usually refers to the relationship between the brightness of two adjacent areas such as a book and its desk surface. The two areas may be equal in brightness 1:1, an ideal condition which hardly ever exists. The surrounding area may be brighter than the book; this occurs infrequently but visual sensitivity is markedly reduced. However, the most common condition encountered is when the book is brighter than the surrounding area. Tinker [60] suggested that a ratio of 3:1 was satisfactory, but beyond 5:1 in favour of the book visual sensitivity is impaired.

In the same study Tinker [60] found that the temperature of the reading environment had an important effect. He recommended that the preferred temperature for reading should be between 60 to 65°F with good ventilation. Wyon [72] supported this, and added that "if the air temperature is 27°C or 80°F there is reduced reading speed and comprehension".

Bronzcroft and McCarthy [11] found that noise had "a detrimental effect on reading ability". Both Dennis [21], and Meddick and Griffin [45] showed that vibration of text increased errors and reduced reading speed as retinal images became blurred. A finding of particular importance for the Royal Navy was by Brand et al [6]. They found that the actual movement or motion of a reader and the consequent sickness affected subjects' ability to add columns of numbers.

Such findings from research show that environmental factors are prominent in bringing about visual fatigue, which leads to ineffective reading and poor comprehension. Clearly there are many other potential variations in reading conditions. These include the visual acuity and tolerances of the reader, print and paper size, interest of the text and the amount of time spent reading. It is therefore not possible to set out precise recommendations concerning the optimum conditions for reading, but research findings do provide some useful guidelines.

Writers of instructional text should, however, be aware of the environmental constraints which may limit the effectiveness of their communication. While classrooms in shore establishments should be able to meet the minimum environmental conditions necessary for effective reading, it is probable that ships cannot. Reading at sea is likely to be performed under difficult conditions which cause visual fatigue: the reading of maintenance manuals or task books in confined machinery spaces is an example. This will become even more relevant as the amount of 'on the job training' increases. Writers need to use every strategy possible to help achieve effective reading by their readers. This could encourage personnel to read beyond the minimum standard to perform a task or learn about a topic, even if environmental conditions are not fully satisfactory.

4. CHARACTERISTICS OF THE READERS

The single most important consideration in the assessment of readability is the reader, yet the traditional method of writing is from the viewpoint of the writer. This may be at the wrong level for the intended readers. Bruner [13] stated that materials should be organised to the learner's structure and not the writer's, while Lewis and Cook [40] suggested that writing and reading should be considered a co-operative venture and not a one-way process. Unfortunately there are difficulties in achieving this. Individuals show wide differences in reading fluency, familiarity with material, range of cognitive abilities and attitudes towards reading. As Wright [69] commented, "Readers have a variety of reading strategies and purposes, readers differ in their preferred strategy for a particular task". However, in spite of individual differences it is necessary to describe in general terms factors which will affect all readers to a greater or lesser extent.

It is essential that writers of instructional text should have as much information as possible about their intended readers' educational, intellectual and reading abilities, and previous experience with the particular topic. Much useful information may be found in personnel records. However, the most useful but complex areas for analysis are motivation and interest.

The degree of motivation which readers display depends upon the nature and quality of interest of the text, and sources of motivation. An interesting text is one which is found enjoyable by the reader. This is essentially an affective response, and may reflect either stable, long-standing aspects of an individual's personality or temporary emotional states. In either case the effect upon interest is very strong, and it plays a significant part in determining tolerances of

difficulty in the text. A text may also be considered interesting because of the intellectual stimulus it provides, or because of the way in which it assists in solving problems. Interests with this cognitive basis may reflect elements in the individual's character such as curiosity. Such an emphasis is on reading for information. A reader's attitude to a text is probably determined by the nature of his primary interest - affective or cognitive. There is clearly a middle area between these two states as well.

The most powerful factors influencing motivation to read are intrinsic, whether affective or cognitive. A reader may be so highly motivated that he reads material well above the level of difficulty to which he is accustomed. Studies have shown that the adoption of a compelling purpose can often help readers to overcome both their own and textual shortcomings. External factors such as examinations may also influence attitude towards a text and the way in which it is read. However, the use of external incentives often indicates that the reader is not behaving out of interest but from compulsion. It appears impossible to predict precisely the way in which a wide variety of influences can affect the reading performance of any individual.

Klare [35] examined the influence upon readability scores of a motivational state described as a 'set to learn', that is, a disposition or attitude towards a task which affects a person's performance of a task. A weak 'set to learn' was characterised by the adoption of a mechanical or habitual approach to the reading task, whereas a strong 'set to learn' was characterised by a more deliberate attack, involving a regular eye fixation pattern and different speed of reading. Klare [35] found that easier passages were read more quickly - whether a strong or weak set was adopted - but that comprehension of the more readable passages was only higher where a strong 'set to learn' existed.

A further reflection of the motivational state of the reader which affects reading performance is the 'principle of least effort' expounded by Zipf [73]. This stated that a person minimises the amount of effort necessary to obtain a certain goal.

Klare [35] found that preferences for reading material were governed by the simplicity of the text - even among College students. He reported that students usually read more of simpler texts than the more difficult, thus confirming Zipf's [73] assertion. These findings illustrate the complexity and problems of motivational influences in studying readability of text.

If the choice of material is left to the reader then performance will usually be below that which the reader could achieve. In practical terms therefore, a readability measure is required which can be used to assess the extent to which a reader is reading for choice, and the extent to which his level of performance could be raised by the presence of a strong 'set to learn'.

Levels of interest vary greatly among individuals. De Charms [16]

commented that "human action is influenced by a vast storehouse of personal experiences", and that "reading ability is associated with many factors".

Abrahams [1] found that a reader's terminal educational age, that is, the age of completion of full-time education, had a high correlation with the extent to which an individual finds any form of reading compelling.

Bernstein [4] identified a dichotomy in language use between elaborated and restricted codes. Restricted code is the language of implicit meaning and is severely context-bound. It is characterised by grammatically simple, short, often unfinished sentences. Symbolism and the use of abstract concepts are of a low order. Bernstein [4] found extensive use of restricted code among the lower working classes. In contrast, elaborated code gives access to universalistic orders of meaning. It is explicit and less bound to a given context. It is grammatically correct, and is the language of the middle classes and the school room. As most instructional text is written in a form of elaborated code, this presents an immediate difficulty for a poor reader when compared with his more natural restricted code.

Fillenbaum [24] showed that individuals' expectations may well dominate their interpretation of statements. Purves and Beach [50] tried to find an explanation for the considerable variability among individuals in their response to written text. They concluded that:

> Readers preferred particular material if the subject matter was related to their personal experience.
>
> Readers became more involved in the material when it was related to them.

The more personal or intense the reader felt about the material, the greater was the likelihood that an inaccurate interpretation of the writer's intent would be made. When reading material that conflicted with their own views, readers were likely to misinterpret it, and select only the parts with which they agreed. They could even reject the text entirely.

Waller [66] supported these conclusions, and pointed out that readers start their encounter with written information by looking for particular sorts of information. He suggested that readers interpret what they read on the basis of prior knowledge and expectations. This view is supported by Rothkopf and Billington [51] who showed that readers' purposes could differ significantly, and that readers pause longer over material considered relevant to a subsequent text than other material.

As Wright [70] commented, "readers' interactions with print are very different from the model of a passive radio receiver which faithfully transduces the signals from the transmitter." It is clear that the interest and motivation of the reader plays a significant part in determining how text is read. Interest depends upon how the reader feels at the time, what he needs to know, and the influence of his previous experiences. Factors in the text itself have also been found to influence

the extent to which a reader enjoys and understands what he reads, and for how long and effectively he continues to read. Good instructional text is geared to a reader's ability, purpose and interest. It will vary in elements such as vocabulary, concepts, density of ideas and organisation of material. Because of enormous individual differences among readers it is unlikely that any one piece of text, however well-researched and written, will be completely suitable for all types of readers. However, writers could benefit from an awareness of potential problems in matching readers and text.

In common with other large organisations the Royal Navy can be expected to recruit some personnel who have reading and learning difficulties. Vernon [64] suggested that reading difficulty may be associated with many factors such as intelligence, discipline and motivation, social background, socio-economic status, exposure to language and books, and cultural differences. As most writers are very familiar with the subject material it is unlikely that they will be sensitive to problems experienced by the novice. If they are not fully aware of the background of their readers, their writing will probably be less effective than it should be.

A mismatch between reader and text is more likely now than ever before. Schools are using more audio-visual aids, while in the home technological innovations in communication have reduced the need for the skills of disciplined and effective reading.

The analysis of reader-related factors in readability proves very complex, but must be undertaken as fully as possible. Unlike teaching or training there is often no adequate feedback available to the writer to assess his effectiveness. This further emphasises the importance of proper planning and preparation of instructional text. It must present the reader with a balance of familiar and new material which is clear and enjoyable to read. It must also contain an optimum density of new ideas or facts for a given class of reader. In this way it should be possible to increase both the rate and ease with which information may be absorbed.

As Tichy [59] commented "There is a need to appreciate the context in which material will be used, and a sensitivity to the requirements of different kinds of readers". However, very often it would appear that these considerations are not taken into account by writers in the Royal Navy.

5. METHODS OF ASSESSING READABILITY

Reading and readability involves the complex interaction of many aspects of the reader and text. Vernon [65] noted that the reading process involved the complex integration of processes of human behaviour such as perception, language acquisition and thought. He pointed out that reading success depended on the possession of the necessary cognitive abilities and motivation to acquire and operate such abilities.

There appear to be four main psychological processes involved in reading:

(1) Visual perception of printed material.
The decoding or word perception discrimination of simple shapes and patterns, and analysis of complex forms of words into elements. A good visual memory is essential.

(2) Auditory linguistic perception of and memory for speech sounds.

(3) Intellectual processes.
These are various and ill-defined. However, it is essential to understand the writer's meaning, as the purpose of reading is the reconstruction of that meaning. The element of meaning is very complex, it is highly personal and exists in the mind of both writer and reader.

(4) Motivational processes.
These are essential for effective reading. Even though elements of visual perception, auditory linguistic perception and intellectual processes are fulfilled, they may be nullified if motivation is not present.

Readability studies have been grouped together - regardless of what they are supposed to be measuring - but three main themes may be identified:

(1) When defined as ease of reading, readability has come to be measured by the use of word recognition speed, error rates, number of eye fixations per second and the like. All of these elements relate to primary skills and are measures of visibility or legibility.

(2) When defined as interest or compellingness, readability has been measured by reference to human interest, density of ideas and aesthetic judgements of style.

(3) When defined as ease of understanding or comprehension, measures have referred to the characteristics of words and sentences such as their length or frequency of occurrence or complexity.

Of the three alternatives the third has been most frequently used because it presents fewer problems for theoretical, technical and practical reasons. It also offers greater possibilities for wide and frequent usage. However, such measures do not include all the factors essential for comprehension, as they give no indication of content or clarity of expression.

Lewis and Cook [40] defined as many as ten potential problem areas which could cause ineffective reading: the writer, the reader, the topic, the communication channel, language, confusion about the topic, insufficient time, absence of clear objectives, readers' lack of attention and interest, poor reading environment. Clearly, reading difficulty is not only the language problem of understanding words and sentences. As Hebb and Bindra [30] observed "It also involves the way in which sentences are related to one another in the paragraph and paragraphs in a chapter

or section". Some writers use simple and short sentences but their text is still difficult to read. Recent studies such as Tzeng and Alva [62] suggested that individual sentences cannot be processed alone, but that it is the overall theme which defines the meaning of the processed sentence. Sherman and Kulhavy [53] supported this view, and suggested that manipulations which concentrated on thematic rather than word structure may be more likely to increase an understanding of how prose is learned and remembered.

There have been many attempts to assess the readability of text using a variety of techniques. The methods which have been most commonly used are:

(a) Subjective Assessment.
(b) Objective Question and Answer.
(c) Readability Formulae.
(d) Sentence Completion.
(e) Summary and Analysis of Meaning.
(f) Graphs, Tables and Charts.
(g) Computer Assistance.

(a) Subjective Assessment

In the absence of convenient, quantitative methods most assessment of the readability of text has involved subjective judgement. The writer uses his personal judgement about content, style, vocabulary, format and organisation. This is based on previous experience and previous text used. In the Royal Navy as in other organisations it is likely that writers are so experienced in their topic that they have difficulty in appreciating potential readers' problems. It is also possible that writers may be more concerned to impress their seniors than to express themselves clearly to their readers. This is based on the widely-held but inaccurate belief that complicated writing and difficult vocabulary is an indication of intelligence. Analysis of some Royal Naval text and civilian manuals used by the Royal Navy suggests that writers rarely omit information - even if it is not fully relevant. This often adds considerably to the reading and learning load.

Studies of systems of marking examination papers have shown that the inadequacies of individual subjective judgements may be improved by the use of groups of examiners. Moyle [46] found that assessment by panels is much more consistent than individual assessment. Similar results have been found with regard to the wide variability in human judgement over readability (Hartley and Trueman [29]). Klare [38] commented that "Individual judgements of readability are likely to be in error". There is, however, a risk when using group assessment that one dominant group member may control the group decision.

Because of the unreliable nature of the subjective assessment of readability this method has been largely superseded by more objective and valid measures.

(b) Objective Question and Answer

These methods have frequently been used to measure the difficulty of a passage, and as a criterion against which other measures may be compared. Popham [48] and Swezey [57] considered criterion-referenced tests to be the most appropriate measurement technique for determining whether a learning or comprehension objective had been achieved. However, the procedure - which measures the comprehension of content - although more impartial and controlled than subjective estimates, has limitations which restrict its use.

It is impossible to be sure whether a given response is a reflection of the complexity of the passage or merely a reflection of the difficulty of the question. The response to questions occurring in the same order as ideas in the passage differs from a response to a set of questions which have been given in random order. The conditions under which the questions are asked also affects the outcome. Such measures are only concerned with comprehensibility, and do not provide any indication of the quality and interest of the text.

In practice objective questions of the multiple choice type have frequently been used to test recall of content. These questions usually take a form in which the reader has to mark a correct item from a range of alternatives. They have the advantage of being easily scored. However, they are limited in usefulness as responses have been found to be affected by the range and type of alternatives offered to the reader. Scores may also be affected by guessing. The proper preparation of multiple choice items requires a detailed knowledge of test construction. This is rarely possessed by individuals involved in assessing readability. Multiple choice questions are affected by the ability of the reader to make an inspired guess based upon an imperfect understanding of content. They therefore provide an inadequate measure of readability.

(c) Readability Formulae

Formulae are the most frequently-produced and widely-accepted methods for measuring readability. They are based upon an analysis of easily identifiable aspects of text. Each formula samples one or more of the primary, intermediate or higher order reading skills.

The procedure usually adopted involves computing a multiple linear regression equation. This is related to measurable characteristics of the text and its comprehensibility. Characteristics chosen have tended to be the average number of words in each sentence or the proportion of polysyllabic words in a passage. Most equations have been limited, and have only involved measures taken within sentences not across sentences. Characteristics such as ideational density, organisation, obscurity of expression and the like have not been considered.

In practice the formula produces a score. This indicates the

difficulty of a sample of text, and a rating is applied according to a judged scale. If the sampling procedures proposed by the constructors are carefully followed, it is assumed that the score and grade reflects the reading difficulty of the whole text. Many measures of this type have been developed, mostly in the United States, which have proposed levels of reading difficulty corresponding to a school grade. Williams et al [67] described 48 readability formulae which were developed prior to 1973. They vary widely in the number and type of characteristics used, and the size of samples required. Some have not been tested and validated systematically and have not been accepted as genuine formulae.

There are five main problems in trying to evaluate the effectiveness of such formulae:

(1) Each formula requires the systematic selection of samples, varying in number and length. Consequently these selection procedures may become very lengthy if the researcher tries to be rigorous. In practice a balance needs to exist between the accuracy required by the researcher and the practical needs and constraints of the user. This is difficult to achieve successfully.

(2) All formulae involve the use of a word measure or sentence measure. This reflects the conclusion by early researchers that reading difficulty is centred around factors at word and sentence levels, and that such factors are easily measured. This does not necessarily stem from empirical data on language processing, therefore it may be argued that such factors lack construct validity. However, the practical value of using easily identifiable factors at these two levels makes them a popular choice in the construction of formulae.

(3) Both word length and sentence length can be unreliable as indices of readability. As Wright [70] commented "Sentence length is not a causal factor in generating problems of comprehension - it is only a correlate". This does not, however, mean that word or sentence length may be completely rejected as a relevant factor. Longer words and sentences do tend to be more difficult than shorter words and sentences. Such measures reflect the effect of memory upon readability. This is particularly important in the case of less-able readers.

(4) Although the factors used in formulae are easy to identify and use, they do not account for all the elements which must be involved. Factors such as the reading environment, typography, organisation, motivation, interest, density of ideas and obscurity of expression have been shown to have an important function in readability. These are the very issues which are emphasised in guides for writing readable text eg Klare [36].

(5) Taylor [58] criticised formulae for being particularly insensitive to the effects of textual factors upon specific individuals or small groups. He argued that as conventionally used, readability formulae deal only with one side of the matching exercise - the text. He proposed that other measures are necessary to reflect factors in particular readers which influence readability.

Formulae were the earliest and most widely developed objective measures used to assess the readability of text. As Hartley et al [29] comment, they are more reliable than the varied and subjective judgement of individual writers. However, there are many shortcomings as Bormuth [8], Klare [37] and Macdonald-Ross [44] pointed out. Formulae are less useful for technical writing and reference manuals than normal prose, but probably the most serious limitation is that although materials which score badly are usually difficult to understand, so are some of the materials which score well.

Such methods seem best used to provide an approximate rather than precise guide of potential reading difficulty. Klare [37] reported that formulae scores correlated very highly with pooled ratings of writers. He proposed that they are therefore useful as predictors where speed is required rather than accuracy. However, formulae are restricted in use. They do not indicate causes of difficulty or prescribe how to produce more readable writing.

(d) Sentence Completion

Sentence completion measures are a familiar and long-established means of assessing comprehension of text. In practice, sentences are taken from the passage and certain words omitted. The degree of comprehension is the extent to which a reader can replace the omissions correctly. The words to be replaced are usually chosen to reflect only the content of the passage, and often have little or no connection with linguistic complexity.

The principle was amended by Taylor [58] and under the title of the Cloze procedure it is used as a measure of readability. The term 'cloze' is derived from the Gestalt term 'closure'. It is used to describe the tendency for a person to complete or make whole an incomplete pattern, and to see complete patterns as figures more readily than incomplete ones. Taylor [58] defined a cloze unit as "any single occurrence of a successful attempt to reproduce accurately a part deleted from a message by deciding from the context that remains what the missing part should be".

Use of the procedure involves therefore the deletion of a number of words randomly determined or at fixed intervals - usually every fifth or tenth word. Subjects are asked to complete the passage, and the number of correct responses is scored. Those passages on which high scores are obtained are regarded as more readable than those giving low scores.

The Cloze procedure possesses a number of useful characteristics:

(1) It appears to reflect the total of all influences which interact to affect readability. In doing so it comes nearest to incorporating - in combination - all the elements involved in the definitions of reading. These include a reader's prior knowledge of content and interest.

(2) The performance of the reader is measured on actual samples to be read. Few other measures involve such a combination. Previous methods examined the two sides to be matched separately using different criteria. When the Cloze procedure is applied, both reader and text may be assessed simultaneously through one measure. This gives the method a greater face validity and reliability than other methods.

(3) The procedure is an improvement over conventional sentence completion exercises as it assesses comprehension in a continuous prose passage - rather than a series of unrelated sentences. It measures the ability of a reader to use a variety of contextual inter-relationships in completing any particular blank. It deals not only with specific word meanings, but also the ability of the reader to respond to his own language pattern. The procedure therefore reflects the total language ability of the reader.

(4) Bormuth [7] concluded that Cloze tests were valid and reliable measures of reading comprehension, and that such tests were more effective than other assessment measures.

(5) The procedure is easy to apply, and does not require detailed knowledge or training in use.

However, there are limitations. Gilliland [25], [26]) suggested that the procedure is constrained in that it measures only readability but not necessarily the predictability of text. Klare [36] complained that words may be correctly restored to the text on the basis of familiar patterns of expression while the passage remains only vaguely understood. The most serious difficulty is that, like formulae, the Cloze procedure may not reflect all types of comprehension. Although materials which score badly are probably difficult to understand, so may some materials which score well.

Writers could, however, find that the procedure is a sufficiently accurate measure to assess readability levels of text. It could help identify specific difficulties. If a series of low scores suggested that a passage was too difficult for the intended readers, then indices from readability formulae could be applied in turn to find the difficulty. For example, if words are too long, then a subjective evaluation of the long words would be useful. If sentences are too long, then an examination of sentence complexity would be useful. If word and sentence elements seem no problem, then an analysis of paragraph structure would be useful. At the highest level, difficulty

may be caused because of the context of the passage. In this case the number of ideas or facts may have to be reduced.

The Cloze procedure seems best described as 'an index of' rather than 'a measure of' comprehension. Used as such it could provide a very practical and reasonably accurate tool or guide for helping writers to identify potentially difficult places in their text.

(e) Summary and Analysis of Meaning

A frequently used method of assessing the level of understanding is to ask readers to summarise the text. However, there are problems in using such methods. Gilliland [26] pointed out that they are inadequate tools for use in readability studies, as the production of a response included many skills which bear little relationship to those required in comprehension. In addition to such technical limitations, the method only assesses the extent to which the reader can select the content of a passage. It does not reflect other components of readability such as fluency. A further difficulty in using summary methods is that they must be assessed subjectively by a marker. This is unreliable, and inadequate for providing a systematic and accurate measure of readability.

Analysis of meaning involves the analysis of semantic and content variables in text (Augstein & Thomas [3]). It uses a procedure aimed at displaying the meaning structure of a text. One technique uses a subjective flow-diagram analysis (Augstein [2]), which may be completed at any chosen level for any length of text. It is claimed that the procedure provides an opportunity for readers - or writers - to display the structure of meaning they attribute to a particular text. It is suggested that this can increase an awareness of how meaning is used, developed and understood.

The procedure could be a useful tool for displaying the 'ideas density' in a text and the relationships that exist within it. This could be a valuable aid in helping display the views of writers as individuals or in groups. However, there are constraints. The procedure is time-consuming to use. It is text-based, and therefore seems more suited to linguistic considerations than user-based material and graphics, both of which are important in instructional text. The procedure therefore seems useful as a measure of comprehension rather than the assessment of readability.

(f) Graphs, Tables and Charts

Such methods have been developed to display the assessment of readability scores. Their advantage is that they require little or no calculation, since the results are related to a set of previously-prepared tables. They are an easier and more familiar technique for preparing and evaluating data than formula. However, it is still necessary to select samples from text, and to count the incidence of one or more factors. Few applications are in use.

(g) Computer Assistance

Recently high-speed digital computer programmes have been developed to assess the readability of text. Siegel [54] described a system which allows the calculation of various measures such as textual characteristics and provides diagnostic information. However, it may only be used for prediction purposes, and does not suggest alternative wordings or sentence constructions. As Siegel [54] commented "Such decisions are best left to the technical writer".

It seems, therefore, that at present computer assistance is most useful only in helping the writer record and store language in a simple and efficient way rather than decision-making. With the increase in use of machines like word processors it may well prove possible to programme guidelines for effective writing. In this way the word processor would draw the writer's attention to basic textual shortcomings. However, its use will be constrained in that it will only be able to deal with basic elements of the writing process.

In examining the various methods of assessing readability, four criteria appear to be important in determining which method to use:

Accuracy
Ease of application
Ease of marking
Ease of calculation.

Researchers have found such criteria difficult to meet, as the accuracy of a method decreases with ease of application. It is often impossible to achieve a satisfactory balance between conflicting needs. As Wright [70] stated "There is no characteristic of the text itself which will predict precisely how easily it can be read". Even if an assessment method appears easy to handle, it may not be in practice. In a recent report commenting on the application of the simple Forcast method to assess readability of United States Air Force publications, some interesting implications emerged (Hooke et al [31]). Although the method was intended to be easy to use, it was found that a substantial number of those responsible for rewriting publications were not able to use the formula to estimate accurately the reading grade level of their material. The research concluded that their writers needed additional training to use the formula properly, and that "Given the relatively crude ways employed at present to estimate the literacy gap, it is not appropriate to insist that writers hit their targets with a great deal of precision". This further reinforces the view of how complex is the assessment of readability.

6. THE PRODUCTION OF INSTRUCTIONAL TEXT

"Do but take care to express yourself in a plain, easy manner, in well-chosen, significant, and decent terms, and to give an harmonious and pleasing turn to your periods: study to explain your thoughts, and set them in the truest light, labouring, as much as possible, not to leave

them dark nor intricate, but clear and intelligible".

Cervantes : Don Quixote

The aim of all instructional text and graphic devices should be to achieve maximum clarity and arouse maximum interest in the reader. Clearly there are a considerable number of factors involved in effective writing and presentation which must be considered when taking production decisions.

Illegible or badly-presented information can reduce a reader's efficiency and may well further result in negative reactions. There is much more research available to guide decisions over issues such as legibility and comprehensibility than over issues such as motivation and attitude change. This probably reflects the relative ease of investigating the different issues. However, it is increasingly being realised that effective communication depends on content, linguistic structure and psycholinguistic factors as well as the overall presentation and setting out of information.

Clark and Clark [18] suggested that there were three stages which enabled a listener to utilise a spoken message:

Identification of the meaning of the message.
Integration with memory for other relevant information.
Performance of an appropriate act.

All three sets of processes apply to individuals reading instructional text, and are influenced by many variables such as the characteristics of the readers themselves, the reading purpose, characteristics of the text and task constraints. A satisfactory approach to designing usable written materials must be able to handle these factors.

Effective instructional text should be produced in a language and format intended for a particular set of readers. Material should be set out in a logical, sequential and orderly way. There should be an adequate list of contents, a simple but comprehensive index, and 'signposts' such as section headings to help access information. Text should be attractive and compelling, one measure of which is that it should contain an optimum number of new ideas or facts. If everything is new or if nothing is new in a text,the reader is unlikely to persist in reading it. The correct balance is not easy to achieve. As Klare [38] observed, although text needs to be clear and easily absorbed it must be set at the correct level of maturity. Unskilled adult readers may well react negatively to highly readable content if the presentation appears childish.

Klare [38] added that the maintenance of high levels of motivation in readers is vital. He noted that even when comprehension test scores were not increased by improvements in texts, factors like judgements and preferences may be positively affected. He concluded that these are very important, as they in turn increase the likelihood that reading will be continued.

There is, unfortunately, disagreement even among experienced writers as to what constitutes clear writing. Klare [36] reported that as a result of reviewing 156 suggestions for the improvement of clear and effective writing, only 2 suggestions were listed in as many as 6 of the 15 books analysed. Only 5 elements were listed in as many as 5 of the books. For most of the suggestions there was agreement between only 1 or 2 of the books. Over some suggestions there were actual contradictions between writers.

However, it appears worthwhile to consider strategies for communicating written text other than using traditional approaches. Wright [71], [69] suggested that alternatives to prose such as flow charts, tabulation schemes and graphic presentations could be more effective than prose for displaying some material. Even the use of instructional cartoons may be effective in raising motivation for certain types of reader. A study by Kauffmann and Dwyer [33] showed that American college students preferred learning through cartoons rather than through realistic photographs. The cartoons proved more effective for both immediate and delayed retention of information.

Instructional text used in the Royal Navy follows a traditional and standard format which is neither geared to effective learning or usage, nor reflects current research findings about communicating written material. An example of what may be achieved by improving the writing and setting out of a section of civilian text is presented in Appendix E. Wright [69], however, noted there is no one best way of presenting technical information. Each communication task presents a new set of problems for which new, compromise solutions may be necessary. In a recent paper [70], she suggested that it is difficult to set out principles which would ensure a good match among objectives, human abilities and the performance of a system. She proposed that while applied psychology can offer some guiding principles "they will always be tentative, commonsensical principles". What the applied psychologist can offer that common sense cannot is effective quality control - the testing of new designs to see how well they work.

7. DISCUSSION AND CONCLUSIONS

"If we could know where we are and whither we are tending, we could better judge what to do and how to do it".

Abraham Lincoln

The subject of readability and the production of effective instructional text is complex. It involves co-ordinating the preferences of the subject experts, the knowledge of printing and typographic experts, and research findings of psychologists and information designers. These must all be modified by the practical constraints of time and budget.

There is no conceptual whole for the subject, and it is difficult to see how a single theoretical model could possibly reconcile the many conflicts in the research literature, or account for so many diverse factors. Macdonald-Ross and Waller [43] commented that empirical research

is difficult, expensive and time-consuming. Chomsky [17] pointed out that much of the scientific character of behavioural science "has been achieved by restricting the subject matter studied, and by concentrating on peripheral issues". The classical experimental paradigm seems inappropriate for studying written communication because of the huge number of uncontrollable variables involved. It is proposed that there is a tendency to adopt too scientific an approach in situations which demand a less rigid mode of thinking and behaving. This view is supported by Pirsig [47], who argued that "by carving up reality into black and white, cut and dried segments ... we distort or occlude their essentially organic nature".

Given that a problem exists, there seem two possible approaches to improve matters:

Remedial training in reading for individuals.
Study of materials and writers.

The first approach is difficult, expensive and time-consuming, and there is no guarantee that such programmes prove effective. As Kniffin et al [39] found, while increasing reading time and skills seemed a straightforward way to increase test comprehension, results indicated that the learning efficiency of such an approach was not high. They proposed that it is necessary to analyse whether any possible gain in comprehension is worth the extra cost.

The second approach seems more viable. It is likely that efforts to improve the readability of materials and production skills of writers could be beneficial. This should be particularly effective if directed at readers where motivation and basic reading skills are not high.

There appear to be 3 separate types of text as proposed by Post and Price [49] and Wright and Reid [71]. They suggested that because of the many differences in reading purposes and skills, a multi-level approach is essential. They defined the various levels as:

Directive - dealing with job specific instructions.

Interpretive - commenting on material, and a useful link between the Directive and Deductive level.

Deductive - a methodological prompt.

The Directive level is seen as consisting of procedural instructions which could reduce the number and difficulty of operational or equipment decisions to be made. Improvements could mean that one man might perform a number of jobs with relatively little training, or a less well-trained man might perform a higher grade job.

An Interpretive level of description would need first to be a commentary on the Directive level, allowing the user an insight into the strategy behind a procedure. It would also need to combine this with an explanation of the information which has been shown to be difficult to understand at the Deductive level. Such a description and improvement would allow the user to extend his level of understanding independently.

At the Deductive level a full technical description would be set out. Benefits could be that any suitable reader might become an expert in the context of a particular operation without reference outside the text.

The advantages of arranging textually-presented information in this way are that using the same material a particular job may be performed well, and the novice can train himself to become more proficient. The multi-level nature of the description overcomes the disadvantages of the reader using a purely directive or deductive approach as traditionally exists. In developing the interpretive element, text should become more usable on the job, and data within the whole text would be accessible as a progressive training text. However, successfully-designed text would require a detailed knowledge of a topic or job by the writer at the task analysis level.

Godwin [27] observed that writers of instructional text should analyse exactly what the user is physically doing while interacting with written information. He stressed the need for suitable text design, and asserted that the writer needs to know what the user wants from a text. He proposed that there should be 3 types of text or manual for different functions:

Work - a practical book for ready use.
Reference - for consultation when problems arise.
Training - for individual and group use.

Wright [70] pointed out that there has been little research into the process of writing or techniques for training effective writers. This area appears worthy of further research, and it is recommended that consideration be given to the setting up of a Royal Naval writers' course. Such a course could train and give practice in all aspects of written communication, such as: detailed task analysis in both writing skills and individual subject material, language and meaning control, graphic presentation, using appropriate production strategies and readability predictors. Quality control officers could be trained in how to manage the whole production process and interpret appropriate research findings. In this way writers and quality controllers would be better trained and informed, and the course would provide an opportunity to research further into effective techniques. The research findings presented in Appendix F could provide the basis for such a course.

In trying to find ways of improving written communication Wright [70] proposed a Usability approach. She defined this as the function of the diverse activities which are involved when individuals read. She recommended 3 checks to be made: on content, presentation and usability of a document. This suggests a need to compromise because of the difficulty in controlling all the variables involved. However, it is recommended that the adoption of a form of systematic approach (von Bertalanffy [5]. Eckstrand [22]) to the subject would best incorporate the many interacting variables involved, and recognise that "the whole is greater than the sum of its parts". Recent conceptual development in systems theory suggests that systems be viewed in their totality. An overall systematic approach would bring about more effective writing than an empirical approach which

focuses exclusively on small segments. Such an approach could provide a sequence of steps for developing an effective production solution. The model could recommend procedures to be followed for both prediction and production of instructional text. Such an approach would be in accord with Chomsky [17], who concluded that there were far too many interfering variables in the production of text, and that it was "better to adopt commonsense considerations".

Investment in time and money is essential. As Waller [66] pointed out, the production of written material requires the integration of diverse talents as does a television or radio programme. It should not be underestimated. A team approach is essential, because it is unrealistic to expect any one writer to be fully proficient in the many skills involved. Design and production considerations in one area often have consequences for others.

Macdonald-Ross [42] argued that some experimental approaches achieve purity "at the cost of practical relevance". One of the objectives of a systematic approach is the solving of real-world problems. In order to achieve a practical and effective answer to the problem of producing instructional text the following model is proposed. It is assumed that the organisation has an objective or goal which the writing is intended to achieve. In the case of the Royal Navy this would probably be operational or training objectives. Such detailed specifications must be available or worked out by the writer. The choice of medium used to achieve the specified objective, eg written text, visual display unit or cathode ray tube is usually determined by local circumstances.

In practice there are 10 stages in the production model:

1. The writer should independently ensure that he fully understands the objectives, and if necessary - through task analysis of the subject - consider it in even greater detail.

2. The writer should discuss the content with other subject experts to reduce possible individual bias and error.

3. The writer should find out as much information as possible about the characteristics of the readers for whom he is writing.

4. The writer should find out as much information as possible about the physical environment in which text is to be used.

5. The writer should have access to specialised knowledge about the prediction and production of effective text. A course could help the writer in sensitisation and self-awareness of the fundamental but subtle skills necessary.

A review of the major research findings regarding the production of instructional text is presented in Appendix F. This could be reinforced by the availability of a check list or job aid as in Appendix G.

6. The writer should try to identify potential reading and learning difficulties with the help of a quality control officer. The latter would perform the role of a 'transformer' (Macdonald-Ross & Waller, [44]). He would be responsible for ensuring that text, format, graphics, etc are all co-ordinated and attuned to the needs of the user.

7. A simple readability formula such as Cloze or Forcast as shown in Appendix H should be applied to the first real draft. This should give an approximate prediction of level of difficulty.

8. A production team consisting of the main writer, other subject experts, other writers and a quality control officer should consider the text. Methods of analysis could include readability formulae, analysis of meaning, flow charts etc which could provide a basis for discussion. In the Royal Navy the manager of the team would probably be the quality control officer.

9. The resulting text should be tested for its usability on a sample of the potential target population. Readers would be asked to comment on the difficulty of the text which they - or others like them - might have.

10. The final text would need to be checked periodically for any changes which may be necessary.

Such a model considers the subject, the reader, the reading environment, textual research findings, potential strategies for analysis and a team approach. The procedure would be much more comprehensive and objective than current methods of producing text. It is recommended that the model should be sufficiently flexible to allow users to select the steps which best suit their particular situation. Clearly it would be advisable to work through the complete programme, especially if text is important and is intended to have a long life. However, if text is required quickly, or sufficient personnel are not available, or text has only a short life, even the adoption of part of the model would be an improvement. At present the content of much writing of instructional text appears to be on completeness and accuracy. It is aimed at meeting short-term objectives or goals with little regard for assessing long-term effectiveness. The driving forces in production appear to be time - in meeting often unrealistic target submission dates, and money - an insufficient allocation of man-hours. As a result the organisation receives what it pays for.

Clearly there must be an appropriate level of investment in producing effective instructional text. The model proposed is a compromise, but it is a possible solution to deal with a real-life problem. As Wright [70] concluded "Narrow, specific applied studies often have no generalisable applications, and they are both costly and lengthy to perform with such interactions". However, such a general, practical, and flexible approach could well prove useful. It could improve the prediction and production of effective instructional text in the Royal Navy at comparatively little cost, and even save training time in the long term.

It is recommended that future research be conducted in the following areas:

(a) Production of a report on

'The Management of Written Communication and Instructional Text'.

This would set out and comment on the main potential management problems and difficulties involved in the topic.

(b) Production of a report on

'A Review of Practical Techniques for Producing Effective Written Communication'.

This would complement and extend the work of this report. It would contain a list of practical recommendations and techniques abstracted from a variety of writers involved in the topic.

(c) Production of a refined RN Writer's Guide/Job Aid for the Production of Instructional Text.

This would be a synthesis of practical material extracted from previous work on the topic.

In addition an external contract has been placed with The Centre for the Study of Human Learning/Brunel University. This project aims to complement the present work on Readability. It is examining the Design of Text as an integral part of a self-instructional package for use at sea. Its emphasis is on the design of texts as aids to learning.

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BAB/jms

REFERENCES

1. ABRAHAMS, G., Quoted in McLAUGHLIN, G.H., Proposals for British readability measures, Downing, Brown. Third International Reading Symposium, London (1963).

2. AUGSTEIN, E.S.HARRI, The flow diagram technique. Unpublished document of the Centre for the Study of Human Learning, Brunel University. Contribution to a workshop on evaluating progress in reading. International Reading Association Conference, Vienna (1974).

3. AUGSTEIN, E.S.HARRI & THOMAS, L.F., Tools for raising awareness of the learning process. Unpublished document of the Centre for the Study of Human Learning, Brunel University (1976).

4. BERNSTEIN, B., Theoretical studies towards a sociology of language, Class Codes and Control, Vol I, Routledge (1971).

5. BERTALANFFY, L., von, The theory of open systems in physics and biology, Science, 3, 23-29 (1950).

6. BRAND, J.J., COLQUOHOUN, W.P., GOULD, A.A., & PERRY, W.L.M., L - hyoscine and cyclizine as motion sickness remedies, British Journal of Pharmacology and Chemotherapy, 30, 463-469 (1967).

7. BORMUTH, J.R., Cloze as a measure of readability. International Reading Association Conference Proceedings, 8, 131-134 (1963).

8. BORMUTH, J.R., Readability: a new approach. Reading Research Quarterly, 1, 79-132 (1966).

9. BORMUTH, J.R., Cloze readability procedures. Elementary English, 45, 429-436, (1968)

10. BROADBENT, D.E., Language and ergonomics. Applied Ergonomics, 8 15-18 (1965).

11. BRONZCROFT, A.L., McCARTHY, D.P., The effect of elevated train noise on reading ability. Environment and Behaviour, 4, 517-527, (1975).

12. BRUNER, J.S., Learning and thinking. Harvard Educational Review, 29, 3, 184-192 (1959).

13. BRUNER, J.S., The course of cognitive growth. American Psychologist, 1, 19-32 (1964).

14. BRUNER, J.S., Toward a theory of instruction. Cambridge Massachusetts: Harvard University Press (1966).

15. CHAPANIS, A., Words, words, words. Human Factors, 7, 1-17 (1965).

16. CHARMS, R.de, Personal causation : the internal affective determinants of behaviour. New York, Academic Press (1968).

17. CHOMSKY, N., Language and the mind. New York: Harcourt Brace and World (1968).

18. CLARK, H.H. & CLARK, E.V., Psychology and Language. New York: Harcourt, Brace, Jovanovich Inc (1977).

19. CROSBY, G.C., Readability and the Royal Navy. Unpublished report. Filed in Admiralty Marine Technology Establishment, Teddington APU/T23/108/77 (1977).

20. DALE, E. & CHALL, J.S., A formula for predicting readability. Educational Research Bulletin, 27, 11-20, 37-54.

21. DENNISS, J.P., Some effects of vibration upon visual performance. Journal of Applied Psychology, 49, 245-252 (1965).

22. ECKSTRAND, Description of training system as reported by STAMMERS,R. & PATRICK, J. in The Psychology of Training (1975), 19. London: Methuen (1964).

23. ENGLISH, H.B. & ENGLISH, A.C., A comprehensive dictionary of psychological and psychoanalytical terms. London: Longmans (1958).

24. FILLENBAUM, S., Pragmatic normalisation: further results for some conjunctive and disjunctive sentences. Journal of Experimental Psychology, 102, 547-548.

25. GILLILAND, J., The examination of measures of readability. Reading, 3, 16-21 (1969).

26. GILLILAND, J., The assessment of readability and the curriculum. MERRIT, J.E.(Editor). UKRA: Ward Lock (1971).

27. GODWIN, P., Communication. In JELLIFFE, D.B. & JELLIFFE, E.F.P. (Editors). Community Action - Family Nutrition Programmes (1977).

28. HARTLEY, J. & BURNHILL, P., Understanding instructional text. In Adult Learning, HOWE, M.J.A. (Editor). London: Wiley (1977).

29. HARTLEY, J., TRUEMAN, M. & BURNHILL, P., Some observations on producing and measuring readable writing. Unpublished document. (1980).

30. HEBB, D.O. & BINDRA, D., Scientific writing and the general problem of communication. American Psychologist, 7, 569-573. (1952).

31. HOOKE, L.R., DELEO, P.J. & SLAUGHTER, S.L., Readability of Air Force publications: a criterion referenced evaluation. Air Force Human Resources Laboratory report, AFHRL TR 79 21 (1979).

32. JONGSMA, E.A., Difficulty of children's books: Librarians' judgements versus formula estimates. Elementary English, 49 (1972).

33. KAUFFMANN, S.P. & DWYER, F.M., Effectiveness of cartoons and photographs in in-service training. California Journal of Education Research, 25, 4, 197-204 (1974).

34. KERN, R.P., STICHT, T.G., WELTY, D., HAUKE, R.N., Guidebook for the development of Army training literature. Human Resources Research Organisation. AD-A033 935 (1976).

35. KLARE, G.R., The measurement of readability. Ames Iowa: The Iowa State University Press. (1963).

36. KLARE, G.R., A manual for readable writing. Maryland: Rem.Co., Glen Burnie (1975).

37. KLARE, G.R., A second look at the validity of readability formulae. Journal of Reading Behaviour, 8, 2, 129-151.

38. KLARE, G.R., Judging readability. Instructional Science, 5, 1, 55-61. (1976).

39. KNIFFIN, J.D., STEVENSON, C.R., KLARE, G.R., ENTIN, E.G., SLAUGHTER, S.L., HOOKE, L.R., Operational consequences of literacy gap. Air Force Human Resources Laboratory report, AFHRL TR 79 22 (1980).

40. LEWIS, B.N. & COOK, J.A., Toward a theory of telling. International Journal of Man-Machine Studies, 1, 129-176.

41. LORGE, I., Word lists as a background for communication. Teachers' College Record, 45, 543-552.

42. MACDONALD-ROSS, M., Language in texts: a review of research relevant to the design of curricular materials. In SHULMAN, L.J. (Editor). Review of Research in Education, 6, Itarca, Ill.: Peacock.

43. MACDONALD-ROSS, M. & WALLER, R., Open University texts: criticism and alternatives. Institute of Educational Technology, Open University (1975).

44. MACDONALD-ROSS, M. & WALLER, R., The Transformer. The Penrose Annual, 69, (1976).

45. MEDDICK, R.D.L. & GRIFFIN, M.J. The effect of 2 axis vibration on the legibility of reading material. Ergonomics, 19, 1, 21-23, (1976).

46. MOYLE, D., The teaching of reading. London: Ward Lock Educational (1971).

47. PIRSIG, R.M., Zen and the art of motor cycle maintenance. London: Corgi Books (1974).

48. POPHAM, W.J. & HUSEK, T.R., Implication of criterion - referenced measures. Journal of Educational Measurement, 6, 1-9 (1969).

49. POST, T.J. & PRICE, H.E., Development of innovative job aid concepts: vol 1 description of concepts. Biotechnology Inc (1972).

50. PURVES, A. & BEACH, R., Literature and the reader: research in response to literature, reading interests and the teaching of literature. NCTE (1972).

51. ROTHKOPF, E.Z. & BILLINGTON, D.R., Goal-guided learning from written discourse: a descriptive processing model inferred from inspection time measures. Unpublished document.

52. RYNN, J.B., A readability analysis of the Army notice board information sheets (NBI's) of 1976. Unpublished MA project report. Library of Birkbeck College, Department of Occupational Psychology. (1977).

53. SHERMAN, J.L. & KULHAVY, R.N., Abstractness and prose comprehension. Acta Psychologica, 42, 1, 59-65 (1979).

54. SIEGEL, A.I., WILLIAMS, A.R., LAPINSKY, W.J., WARMS, T.A., WOLF, J.J., GROFF, S.D., BURKETT, J.R., Studies and design. Specifications for Computerised Measurement of Textual Comprehensibility. Air Force Human Resources Laboratory AFHRL TR 76 77 (1976).

55. STICHT, T.G., A programme of Army functional job reading training: development implementation and delivery systems. AD-A012 272/1G1 (1975).

56. STICHT, T.G. & ZAPF, D.W., Reading and readability research in the armed services. Human Resources Research Organisation Alexandria. AD-A034 730 (1976).

57. SWEZEY, R.W., Aspects of criterion-referenced measurement in performance evaluation. Human Factors, 20, 2, 169-178.

58. TAYLOR, W.L., Cloze procedure: a new tool for measuring readability. Journalism Quarterly, 30, 415-433. (1953).

59. TICHY, H.J., Effective writing for engineers, managers and scientists. New York: Wiley (1966).

60. TINKER, M.A., Bases for effective reading. Minneapolis: University of Minnesota Press (1965).

61. TINKER, M.A., Legibility of print. Iowa State University Press (1965).

62. TZENG, O.J.L., ALVA,I.C., LEE,A.T., Meaning specifivity in sentence processing. British Journal of Psychology, 70, 1, 127-133.

63. VANDENBERG, J.D., Improved operating procedures' manuals. Ergonomics, 10, 2, 214-220.

64. VERNON, M.D., The visual presentation of factual data. British Journal of Educational Psychology, 20, 174-185 (1950).

65. VERNON,M.D., Reading and its difficulties. Cambridge University Press. (1971).

66. WALLER, R., Notes on transforming 1-5. Unpublished document. (1977).

67. WILLIAMS, A.R., SIEGEL, A.I., BURKETT, J.R., Readability of textual materials: a survey of the literature. Air Force Human Resources Laboratory AFHRL TR 74 29 (1974).

68. WRIGHT, P., Writing to be understood: why use sentences? Applied Ergonomics, 2, 207-209.

69. WRIGHT, P., Presenting technical information: a survey of research findings. Instructional Science, 6, 93-134 (1977).

70. WRIGHT, P., Usability: the criterion for designing written information. To be published in Processing of Visible Language, 2. KOLERS, P.A., WROLSTAD, M.E., BAUMA, H. (Editors). New York: Plenum Press (1980).

71. WRIGHT, P. & REID, F., Written information: some alternatives to prose for expressing the outcomes of complex contingencies. Journal of Applied Psychology, 57, 160-166 (1973).

72. WYON, D.P., Studies of children under imposed noise and heat stress. Ergonomics, 13, 598-612 (1970).

73. ZIPF, G.K., Human behaviour and the principle of least effort. Cambridge, Massachusetts: Addison-Wesley Press (1949).

APPENDIX A

ROYAL NAVAL EDUCATIONAL AND TRAINING ESTABLISHMENTS

SURVEYED DURING THE PROJECT

HMS CALEDONIA	Engineering School
HMS CAMBRIDGE	Gunnery and Missile Training
HMS COLLINGWOOD	Weapon and Electrical School
CTCRM	Commando Training Centre, Royal Marines
HMS DAEDALUS	Aeronautical Engineering, Air Medical, Safety Equipment and Survival School
HMS DARTMOUTH	Officer Training
HMS DAUNTLESS	Women's Royal Naval Service Training
HMS DOLPHIN	Submarine School
HMS DRAKE	Hydrographic School and Signals Training
HMS DRYAD	Surface Maritime Operations School
HMS EXCELLENT	General Naval Training, Leadership, Management School, Regulator School
HMS FISGARD	Apprentice Training
HMS HERON	Air Direction School
HMS MERCURY	Signal School
HMS NEPTUNE	Polaris School
HMS PEMBROKE	Supply School
HMS PHOENIX	Nuclear, Bacteriological, Disaster Control School
HMS RALEIGH	New Entry Training
HMS ROYAL ARTHUR	Petty Officers' School
HMS SEAHAWK	Helicopter, Observers', Meteorological and Aircraft Handling School
HMS SULTAN	Marine Engineering School
HMS THUNDERER	Engineering College
HMS VERNON	Seamanship, Mine Warfare and Diving Schools

Office Services Educational (Admiralty) who employ Information Officers to edit Royal Navy books were also visited, but were not included in results of survey.

APPENDIX B

READABILITY AND THE PRODUCTION OF INSTRUCTIONAL TEXT

- STRUCTURED INTERVIEW QUESTIONNAIRE

HMS

INTERVIEWEE

APPOINTMENT

1. In what format is instructional text written in your establishment?

2 Who writes the instructional text used in your establishment?

3. What method is used for producing instructional text in your establishment?

4. Do your writers work as individuals or teams?

5. Is your instructional text tested on probable readers before use?

6. Can you define the term Readability?

7. Do you know about strategies available for writing and assessing the effective production of instructional text?

8. Have your writers had any training in the production of instructional text?

9. Have you had any training in the production of instructional text?

10. Has your establishment any problems with trainees' understanding of instructional text?

Thank you for your help.

Do you have any questions you would like to ask me or further comments to add?

APPENDIX C

EXAMPLES OF POORLY-PRODUCED INSTRUCTIONAL TEXT USED IN THE ROYAL NAVY

BR 4007 Guide to Ship Firefighting

(a) Front cover page

What to do in case of Fire.

(b) Back cover page

Fault: Contradiction of instructions.

Front cover instructions state that in the event of Fire an attempt should be made to put out the fire.

Back cover instructions state that in the event of fire it should be reported first.

What to do in case of FIRE

AT SEA

1 Try to put the fire out with portable equipment, **shouting for help at the same time.** If there are two of you, one must raise the alarm immediately.

2 If you are alone and the fire is gaining on you, leave it and raise the alarm by
a 999 call on the ship's automatic exchange, or
NBCD telephone to
HQ1,
QUARTERMASTER or
BRIDGE, depending on the ship's state of readiness.

3 Return quickly to the fire, taking extra equipment if you can, and continue firefighting.

4 On arrival of the fire party, report to the officer or senior rating in charge and stay with him until ordered otherwise.

ALONGSIDE OR REFITTING

1 Try to put the fire out with portable equipment, **shouting for help at the same time.**

2 If the fire is gaining on you, leave it and raise the alarm by:
a 999 call on the ship's automatic exchange, or
NBCD telephone to
HQ1 or
QUARTERMASTER, depending on the ship's routine.

3 Return to the fire and continue to fight it.

4 On arrival of the fire party, report to the officer or senior rating in charge and stay with him until ordered otherwise.

Note In an HM Naval Base the ship must call the local Fire Brigade. In a commercial port or dockyard, the ship must conform to the Port Regulations.

BR 4007

Guide to Ship Firefighting

Supersedes
BR 4007 Ship Firefighting Manual
dated 1969

May 1976

By command of the Defence Council

MINISTRY OF DEFENCE
Ship Department
N/S 50274/75

d. Lubricate the shoulder hook pivots with approved pattern grease and check the locking pin is clear and free from grease.

e. Lubricate the control valve spindle and moving parts of the equalising lever with approved pattern grease.

f. If the apparatus has been under water, strip the demand valve and lightly lubricate the metal parts with approved pattern grease.

g. Check the security of the cylinder bands and examine the cylinder for scores and abrasions.

h. Charge the cylinders to their full working pressure and check the equalising valve for ease of operation.

Smoke Mask

6.53 The smoke mask is used for rescue and work in compartments containing vitiated air. It is simple to use and needs little or no training. It consists of a wide-vision face piece (ICABA facepiece in the new pattern) incorporating an outlet valve, a corrugated rubber breathing pipe incorporating an inlet valve, and a harness to prevent the pipe from pulling on the facepiece as the wearer moves about. An aluminium clamp with a plywood backing is fastened to the breathing pipe, clamping it at the waist belt. (Details of this clamp are in BR 2170, Volume 2, Fig. 33.7). Asbestos-covered hose in 30-ft and 60-ft lengths is provided and can be coupled to the breathing pipe to a total length of 120 ft; with more than this, breathing is difficult. An air filter is fitted to the outer end of the hose and the safety attendant holds this near to his cheek and ear, ensuring that the wearer breathes air as good as that breathed by himself. With the filter close to his ear, the attendant should be able to hear any shouted message from the wearer. The attendant must maintain a firm grip on the hose and take a turn around his body so that accidental release will not endanger the wearer's breathing.

6.54 *After use.* After the smoke mask has been used the inside of the face-mask should be disinfected with hospital Savlon solution (applied with a moist rag) to a recommended strength of 1:200 (or 1:30 for the removal of blood, dirt, etc.). It should then be rinsed with clean fresh water, dried thoroughly, and anti-dim applied to the vizor.

6.55 *Maintenance.* Must be carried out strictly in accordance with maintenance schedule number M. 763q.

REMEMBER

1 REPORT the fire as quickly as possible and, if you can, say where it is and what is burning.

2 A fire can be put out by *cooling* and/or *smothering* and/or *starving*.

3 Water cools most efficiently when it is sprayed.

4 If fire involves electrical apparatus, *switch off the power supply*.

5 *Fresh water spray* and a 2-gallon portable extinguisher filled with fresh water/AFFF mix can be safely used against live electrical equipment at normal ship voltages from a distance of 18 inches or more.

6 *Salt water spray* can be safely used against live electrical equipment at normal ship voltages from a distance of 4 ft or more.

7 Water-spray can be used against a *high-flashpoint* liquid fire *only if it has not been burning for long*.

8 Foam (AFFF) or dry powder must be used against liquid fuel fires, particularly *low-flashpoint fuel fires*.

9 Always back up the use of dry powder with foam.

10 The danger of smoke and toxic fumes. Always use breathing apparatus.

11 A firefighting nozzle set to spray provides a good degree of personal protection.

12 Make sure that firefighting appliances are always left in a fully serviceable and operational condition. If you know that a portable appliance is empty or partly empty, or that a breathing apparatus cylinder is not fully charged, REPORT IT.

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BR 4007 Guide to Ship Firefighting

(c) Pages 6 and 7 Fire Hazards and Prevention

Words 'volatile'

'flammable'

'defective'

'incinerators'

'adhesives'

'combustible'

'accumulate'

'inert'

'stringent'

'renders'

Fault: Words could be difficult for some readers.

Papers and books left untidily in offices, cabins and messdecks, or tucked away near sleeping billets. Bunks left unmade.

Paint and oil splashes in contact with heat; paint pots not returned to store at the end of the working day; too many coats of paint on surfaces.

Containers of volatile liquids incorrectly stowed, or left open when not in use.

Misuse of aerosols.

Dirty gauzes and grease-traps in galley exhaust systems.

Cooking oil, especially in deep-fat fryers, left unattended or allowed to overheat. (This is particularly dangerous if water has been allowed to get in the fat or oil.)

Timber stowed near sources of heat or soaked with flammable liquid.

Bilges, flats, workshops etc. allowed to remain oily, untidy and dirty

Misuse of electrical equipment or use of defective equipment.

Sparks from dirty funnels of incinerators and galleys.

Hazards when refitting

2.5 The fire hazard in ships in dockyards, particularly in refitting ships, is high. A ship undergoing refit has problems regarding fire prevention and fire-fighting rather different from those she has when at sea. The major problems which differ from normal are:

The use of open flames (for example, in welding and burning operations).

The use of low flash-point liquids and other substances (eg adhesives).

Additional materials of a combustible nature.

The arisings of waste and scrap materials which would never normally be allowed to accumulate.

The 'inert' state of the ship, which generally decreases or inactivates the efficiency of installed fire-protection equipment.

Large numbers of civilian workmen on board whose safety must be considered. The difficulty of keeping close check on smoking and the use of electrical equipment.

Numerous temporary electrical cables and distribution boards.

Disruption of normal internal communication.

Ship's company depleted by leave, courses, etc.

Welding and burning operations entail very great risk of fire. Stringent regulations are contained in BR 2170(2), *Ship NBCD Manual*, Volume 2. Part of those regulations require welding sentries to be detailed for all welding and burning which is taking place in the ship. The sentries are to be provided with portable extinguishers, and are to be fully instructed in their duties.

2.6 The fire hazards of a ship in refit make it most important that everyone is FIRE CONSCIOUS. Rounds must be frequently carried out in all compartments where civilian workmen are employed during and after working hours, and in adjacent compartments and spaces.

2.7 During refit, portable extinguishers are distributed around the ship in unlocked stowages, ready for immediate use. Fire locker keys are clearly marked and must be immediately available.

Hazards in war

2.8 Enemy action can create additional fire hazards, but the most effective precautions are the elimination of the everyday hazards, a sound knowledge of firefighting, good ship knowledge and calm confidence.

2.9 Good fire prevention not only reduces the number of outbreaks but renders those which do occur easier to deal with.

BR 4007 Guide to Ship Firefighting

(d) Page 19

(i) 4.18 Expressions LPDs, LPHs, BCF

(ii) 4.22 Operating instructions

Faults: (i) Lack of explanation of abbreviations.

(ii) Run-together format of instructions. Could be improved by writing on separate lines.

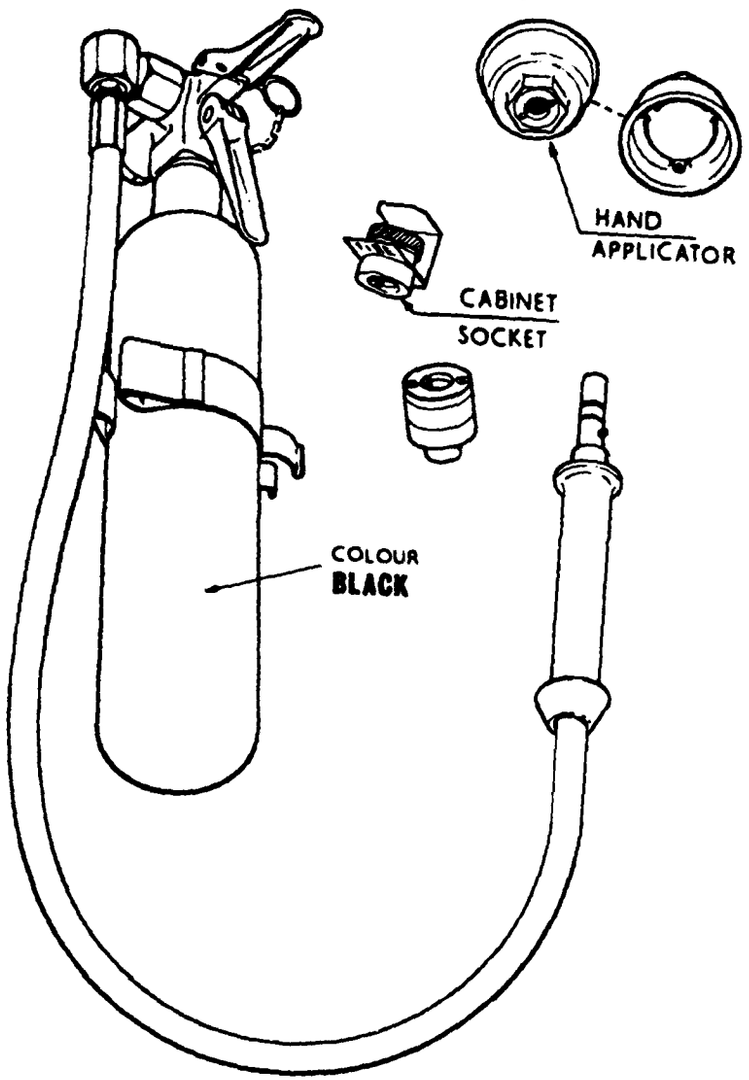


Fig. 4 *2½ lb CO_2 extinguisher with hand applicator*

4.17 The cylinder cannot be recharged on board ship. It must be returned for exchange *whether partially or wholly discharged.*

BCF EXTINGUISHER

4.18 THIS EXTINGUISHER IS PAINTED OLIVE GREEN. It is provided for use in motor transport and will therefore be found in the vehicles in LPDs, LPHs, and any other vessel in which vehicles are carried. It contains 1 kg of liquid BCF, expelled in the form of a vapour by gas under pressure. It evaporates on contact with heat, smothers the fire and inhibits combustion. It is harmless to mechanical and electrical equipment and leaves no deposit.

4.19 The BCF extinguisher is suitable against all types of fire but is preferred against those fires involving liquid.

4.20 After BCF has been used the compartment should be ventilated. BCF extinguishers cannot be recharged on board ship.

P.12 DRY POWDER EXTINGUISHER (Fig. 5 overleaf)

4.21 THIS EXTINGUISHER IS PAINTED BLUE. It is supplied only to ships which carry aircraft. It contains 28 lb of dry chemical powder which is ejected by the pressure given by a CO_2 cylinder which is attached to it. The powder attacks the fire as a jet or a diffused cloud. It is used for quick 'knock-down' of flammable liquid fires, especially to give fire cover during rescue operations from crashed aircraft. Its use must be backed up immediately by major foam appliances. The powder is compatible with foam, non-toxic and a non-conductor of electricity.

4.22 To operate: remove the discharge hose from its stowage; fully open the CO_2 valve by turning the wheel anti-clockwise. Press the squeeze-grip nozzle which gives a diffused cloud when half open or a jet when wide open. Fully opened, the P.12 extinguisher will discharge for 45 seconds. Once the CO_2 seal is broken, the cylinder will empty. The extinguisher must always be recharged after use: full instructions are contained in BR 2170(2), *Ship NBCD Manual*, Volume 2.

BR 4007 Guide to Ship Firefighting

(e) Page 29 Firefighting Equipment

Gas Turbine Pump (Fig 10)

(f) Page 30 Firefighting Equipment

Fig 10 Rover gas turbine portable fire pump

Fault: Diagram on separate page from part of associated text.

4.53 The spray systems in hangars of aircraft carriers and LPHs are fed by their own pumps and are independent of the ship's salt water main, although the system can be cross-connected to the main if required. The system is divided to correspond with the hangar sections and can spray the entire deck space and the contents of the hangar below the sprinkler heads. The system is hand-operated. Because of the amount of water involved and the consequent danger of loss of stability because of free surface, large scuppers are fitted in the hangar space to drain away the water quickly. These scuppers must be kept clear of obstruction at all times.

Flight Deck Salt Water Main (Aircraft carriers and LPHs)

4.54 Aircraft carriers and LPHs are fitted with a salt water main running under the flight deck, supplied by its own pumps and independent of the ship's salt water main. At each hydrant 60 feet of No. 3 size hose is stowed, one end connected to an inline inductor bolted to the hydrant and the other end to an FB10(X) branchpipe (*see* 'Foam-Making Branchpipes' below). A jet/spray nozzle is also stowed adjacent to the hydrant, and can replace the FB10(X) when a waterwall is required.

54

EMERGENCY FIREFIGHTING PUMPS

4.55 Emergency pumps are carried in ships to provide water under pressure in the event of the salt water main being locally inadequate. They will not work at more than about 25 feet above the surface of the water supply, whether this is the sea or a flooded compartment. Most centrifugal pumps are designed to move water only and a small air pump, called the priming pump, is built into the unit for exhausting the air from the suction system when the pump is worked above the level of the water supply. The priming pump, according to type, may be permanently coupled to the power unit, as with the portable electric salvage pump, or engaged by the operator at the start of pumping and disengaged when the pump is primed, as with the diesel pump. With the latter, if suction is lost from any cause, the pump must be primed again and a man must tend the pump ready to do this.

Diesel-driven Portable Fire Pump (Fig. 9)

4.56 This pump unit comprises a two-cylinder diesel engine directly coupled to a single-stage centrifugal pump. The engine may be water- or air-cooled. The

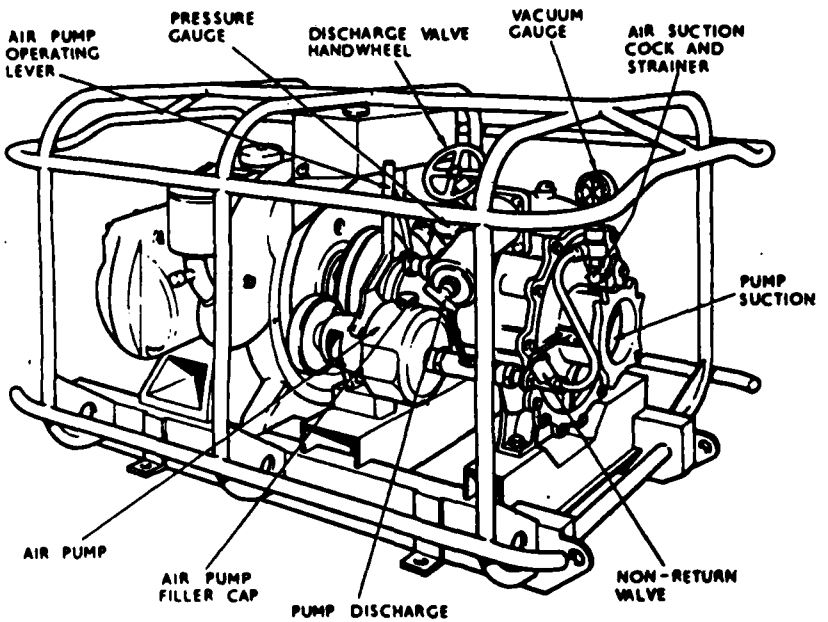


Fig. 9 *Diesel-driven portable fire pump*

nominal capacity is about 27 ton/hour against a pressure of 50 lb/sq in., so that the pump should support one jet/spray or two spray/jet nozzles at this pressure. Flexible extensions of reinforced asbestos are provided for the exhaust pipes from the engine and the unit should *never* be run between decks without the extensions fitted and led to the open air. Care should also be taken to ensure adequate ventilation of the compartment in which the unit is being run.

Gas Turbine Pump (Fig. 10)

4.57 Detailed information on operation and maintenance is given in BR 3607, *Handbook for Rover Gas-Turbine Units.*

4.58 This unit is about 3 feet long, 21 inches wide, 2 feet high and weighs about 225 lb. The turbine runs on dieso and drives a centrifugal pump through

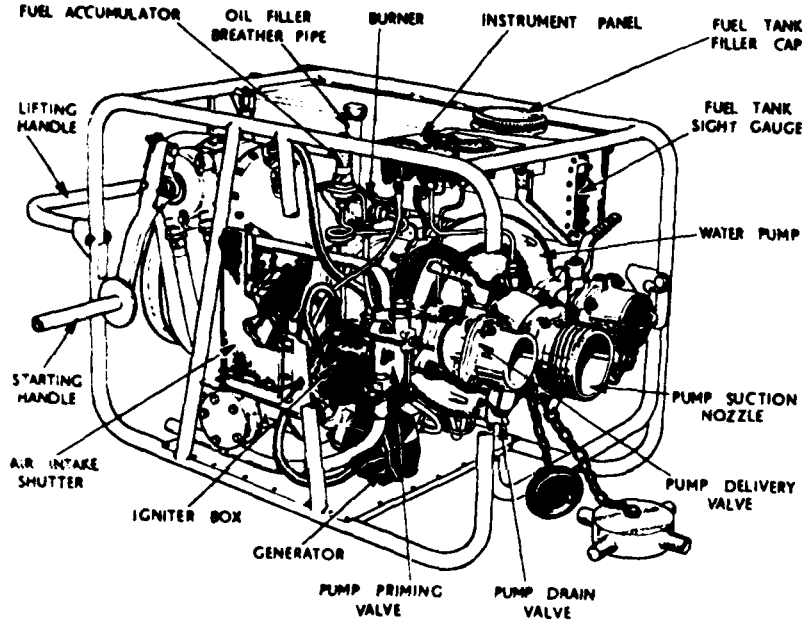


Fig. 10 *Rover gas turbine portable fire pump*

reduction gearing. When operating with a 20-ft static suction lift the pump output is about 49 ton/hour (180 gall/min) at a pressure of 100 lb/sq in. With a 2-ft suction lift, the output is about 120 ton/hour (450 gall/min) at a pressure of 90 lb/sq in.

4.59 The complete unit is contained in an open box-type tubular steel frame and can be carried by two men. It will pass through ships' doors and hatches. The fuel tank contains 4½ gallons of dieso which gives about 25 minutes running at full power. A panel is fitted to the unit and carries:

A combined engine revolutions and 'hours run' gauge;

A combined oil temperature and oil pressure gauge;

A pump vacuum gauge;

A pump delivery pressure gauge.

4.60 Standard size suction hoses and strainer are supplied and the delivery valves are fitted with standard instantaneous hose connections. The left-hand delivery valve is fitted with a 5 gall/min leak-off to restrict temperature rise when the pump is operating with nearly closed delivery valves. Lengths of light-weight flexible hose are provided for discharging the exhaust gases when the pump is run between decks. The exhaust must be run to the open air and the compartment in which the pump is running must be adequately ventilated. Flammable materials must be kept clear of the run of exhaust piping.

Electrically Driven Salvage Pump

4.61 This pump is designed primarily for salvage work (pumping out a flooded compartment) but can be used for firefighting purposes. There are two sizes: 35 ton/hour and 70 ton/hour. The former will support one spray/jet nozzle and the latter two, at a pressure of about 20 to 25 lb/sq in. provided that the pump and the delivery nozzle are both within 20 feet above the level of the water from which suction is being taken. Any increase in height of the delivery nozzle will correspondingly reduce the output.

MAIN FOAM APPLIANCES AND INSTALLATIONS

4.62 These appliances and installations operate from the salt water main and are designed to mix water and AFFF in the correct proportions and aerate the mixture to produce mechanical foam. AFFF, which is non-toxic and non-corrosive, is supplied in 20 litre containers. The mixing and aeration are done either with foam branch-pipes supplied with water from the hydrants or from fixed foam installations.

Foam Branchpipe FB5(X) (Fig. 11)

4.63 This is a light-weight branchpipe producing nearly 500 gallons (2250 litre) of foam per minute at a salt water main pressure of 80 lb/sq in. (*See* Chapter 5). Used with a pick-up spill assembly, attached by a quick-release coupling to the branchpipe, it draws AFFF from a 20 litre container. Continuous delivery of foam at the above pressure will consume about 12 litres of AFFF per minute, so good backing-up in the supply of AFFF is very necessary. The FB5(X) is used in conjunction with the foam inlet tubes fitted to machinery spaces to

(g) Firefighting Tactics

Page 46 5.34

(h) Cartoon of sailor putting out fire.

Fault: Incongruency of instructions and cartoon. Tactics recommended in 5.34 are that CO_2 cylinder should first preferably be used on electrical equipment. "It is safe to use water .... PROVIDED THAT the nozzle is not less than 18 inches from any live equipment if fresh water is being used and not less than 4 feet if salt water is being used.

Cartoon shows Two Gallon Portable Extinguisher (water-filled) being used less than 18 inches from the electrical fire.

5.30 Fires in electrical equipment may be caused by overloading or breakdown of insulation or might be associated with a fire in the vicinity. Patrols, therefore, must be especially vigilant whenever there is a fire on board and a watch must be kept for electrical fires which may start some time after the main fire has been extinguished.

5.31 A fire which may start with solid or liquid fuels and subsequently involve live electrical equipment or circuits becomes, in effect, an electrical fire. It is important, therefore, to switch off all live electrical circuits in the vicinity of a fire if this can be done without detriment to essential services, eg, firefighting pumps.

5.32 When power is off, what was an electrical fire becomes a straightforward fire of the combustibles present and should be attacked with the appropriate equipment.

5.33 If the symptoms are those of a minor fire, (eg, a small smoke emission from within an electronic cabinet or switchboard), these may well disappear once all power supplies have been removed. Some discretion is therefore necessary before deciding to flood a cabinet with water and causing unnecessary damage.

5.34 The actions which should be taken are:

a. *Fires in electrical equipment at normal voltages.* Switch OFF power and attack with CO_2. The use of CO_2 should not be delayed if power cannot be removed, but re-ignition is likely until isolation is achieved. If the above action does not extinguish the fire it should be treated as an ordinary fire and attacked with water. If electrical current cannot be switched off *it is safe to use water in the form of a spray on voltages up to* 440 *V ac or* 800 *V dc,* PROVIDED THAT *the nozzle is not less than* 18 *inches from any live equipment if fresh water is being used and not less than* 4 *feet if salt water is being used.*

b. *Fires in electronic equipments.* Switch OFF equipment if local switch is accessible and attack with CO_2 through injection nozzle when fitted (the socket on the equipment cabinet is normally painted red and marked 'Fire Inject CO_2'), or by opening doors and/or covers when an injection nozzle is not fitted. Switch off and remove fuses of all power sources to the equipment, including alternative sources. If these actions do not extinguish the fire it should be treated as an ordinary fire and attacked with water, observing the precautions given in *a.* above. When the fire has been apparently extinguished, all drawers or sections of complex equipments should be opened to ensure that the seat of the fire has been located.

Floating Oil or Gasoline

5.35 This is sometimes to be met in harbours and dockyard basins. If ignited, it could cause a ship fire. Alternatively, if a ship fire occurs, floating oil and gasoline in the basin or discharged from the ship on fire might ignite and result in a ship-to-ship fire spread. A small area of floating burning oil (but not gasoline) can be broken up with jets and each isolated portion then cooled with spray; foam is needed for large areas and is essential for gasoline. A patch of burning oil can be prevented from spreading by using the wash from a ship's boat.

Aircraft fire on deck

5.36 The following equipment should be used for an aircraft fire on deck:

START-UP FIRE

CO_2

SPILL FIRE

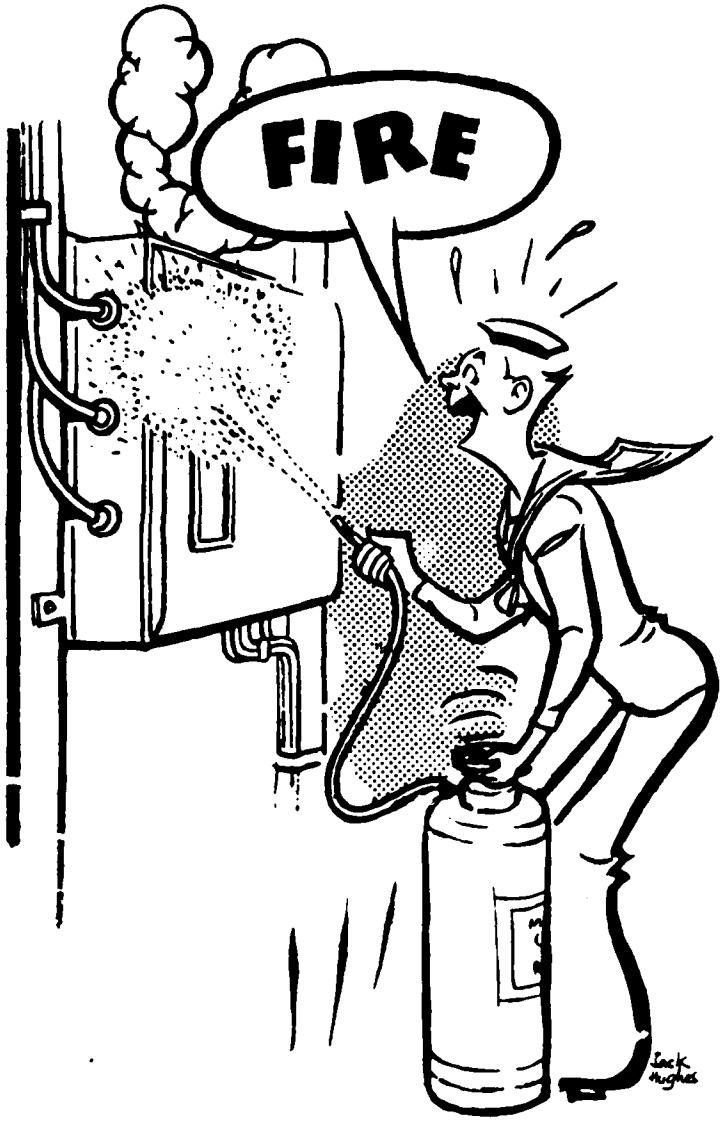
2-gallon portable extinguisher or P.12 dry powder extinguisher.

CRASH FIRE

PD 150 dry powder extinguisher followed by the main foam appliance.

Burning fuel must be smothered by covering it completely with foam.

5.37 If the aircraft fire on deck is a sequel to a crash, the first care must be to rescue the crew. The P.12 and PD.150 dry powder extinguishers are used for this purpose as they give a quick 'knock-down' effect on the fire. They must be followed by use of the main foam FB10(X) nozzle to cover any burning fuel and the aircraft. P.12 extinguishers filled with Pyromet black powder must be used if magnesium is on fire.



Try to put it out and shout for help

1

THE NATURE OF FIRE

1.1 Fire is an ever-present risk in ships. As always, prevention is better than cure. For the safety of the ship and everyone in her, every officer and rating must have a sound working knowledge of the causes of accidental fires and how to prevent, control and extinguish them.

1.2 Every officer and rating must know the right kind of equipment for each kind of fire and how to use it.

1.3 Except for those caused by enemy action or ship accident, most fires on board ship can be prevented simply by attention to:

a. the proper stowage of flammable solids and liquids and their protection from sparks and other sources of heat;

b. the maintenance of clean and tidy living, especially in the disposal of smouldering cigarette ends, matches and other burning or hot material;

c. the correct use of electrical equipment;

d. being fire conscious and observing the relevant regulations.

The causes of fire

1.4 Fire depends on three things being present together: FUEL, HEAT and OXYGEN. The three can be represented by the sides of a triangle (Fig. 1), and fire will not start or continue if one is absent.

FUEL is a combustible solid or liquid which gives off a vapour that will burn when raised to ignition temperature. (Some examples are paint, paper, wood, linoleum, textiles, oils.)

APPENDIX D

ORGANISATIONS VISITED DURING THE READABILITY AND PRODUCTION OF INSTRUCTIONAL TEXT PROJECT

Medical Research Council, Cambridge:	Dr P Wright
Open University:	Dr T Duffy M Macdonald Ross
University of Bath:	Dr N D C Harris
University of Bristol:	Dr E Thomas
Brunel University/Centre for the Study of Human Learning:	Dr S Harri-Augstein
University of Durham:	J Gilliland
University of Keele:	Dr J Hartley
University of Wales Institute of Science and Technology:	H Kune

APPENDIX E

EXAMPLES OF EMERGENCY INSTRUCTIONS FOR CIVILIAN AIR TRAVELLERS: ORIGINAL AND IMPROVED VERSIONS

Text was revised by Hartley and Burnhill (unpublished document, Eighty Ways of Improving Instructional Text, HARTLEY, J. 1980)

IMPORTANT INFORMATION FOR OUR PASSENGERS

Even though you may be an experienced air traveler, there are certain features of this airplane with which you may not be familiar.

AUTOMATIC OXYGEN SYSTEM

The higher altitudes at which this aircraft operates require the prompt use of the automatic oxygen system in case of any sudden change in cabin pressure. Should a decompression occur, oxygen masks will drop down. Take nearest mask and promptly place over nose and mouth. BREATHE NORMALLY (NO SMOKING PLEASE).

SEAT BELTS

Even if the "SEAT BELT" sign is turned off in flight, it is recommended that you keep your seat belt fastened, whenever you are in your seat.

FLOTATION SEATCUSHIONS

The cushion on which you are sitting is designed to keep you afloat. In the event of a water landing, grasp the cushion at the rear, pull it forward and take it with you.

EMERGENCY EXITS

There are nine exits provided for your use. The chart below will show you the one closest to your seat. The exits over the wings are removable windows. For easy access to the window, push seat back ahead of the window forward. The two exits at each end of the cabin are doors equipped with fast operating evacuation slides. There is also a door in the rear of passenger cabin. REAR CABIN EXIT (STAIR). (If usable, will be opened by a crew member.)

The original text.

IMPORTANT!

This aircraft has special safety features.

Read this card carefully.

AUTOMATIC OXYGEN

If, during the flight, there is a sudden change in cabin pressure, oxygen masks will drop down automatically.
If this happens
- take the nearest mask
- put it quickly over your nose and mouth
- breathe normally
- put out all cigarettes

EMERGENCY EXITS

There are nine emergency exits.

The chart on the back of this card shows the exit nearest to your seat.

The two exit doors at the end of the cabin are fitted with chutes for sliding down.

To get out over the wings you have to take out the windows.
To make this easier, put the seat-back down when you are trying to get to the window.

The door at the back of the cabin is labelled REAR CABIN EXIT (STAIR).
This door will be opened by a crew member.

FLOATING SEAT CUSHIONS

Your seat cushion will keep you afloat if we make an emergency landing in the sea.
Get hold of the cushion at the back, pull it forward, and take it with you.

SEAT BELTS

We suggest that you keep your seat belt fastened when you are seated - even when the SEAT BELT sign is turned off.

The same text revised

APPENDIX F

GUIDELINES FOR THE PRODUCTION OF INSTRUCTIONAL TEXT

1. Size and Shape
2. Organisation
3. Headings
4. Typography
5. Clarity of words
6. Questions
7. Clarity of structure
8. Complex material
9. Illustrations
10. Colour
11. Figures
12. Tables
13. Graphs
14. Charts
15. Reading conditions
16. General points

1. Size and Shape

The size and shape of a book has an effect on its readability. Small - down to 8" x 4", thin,- no more than 300 pages, containing information on only one set of related tasks, are thought to be aids to efficient use and information retrieval.

(Foley and Cann 1972)

The page size of text should conform to the sizes recommended jointly by the British Standards Institution and the International Organisation for Standardisation.

A4 and A5 are most commonly used.

The standard is rooted in the principle that a rectangle with sides in the ratio 1 : 1.414 (1 : $\sqrt{2}$) may be halved or doubled without changing the ratio of width to depth.

This ratio is also recommended for formats associated with overhead transparencies, slides and microfiche systems.

(Hartley and Burnhill 1977)

If the author knows in advance the page size of the final product then this helps in the choice of suitably sized illustrations and graphic materials.

(Hartley 1978)

The design of the printed page must suit the text printed on it.

(Demilia 1968)

Pages should lie flat. Curvature causes distortion. Narrow margins have been shown to increase visual fatigue.

Thick books with a strong spine and narrow margin are particularly difficult to handle and read properly.

(Demilia 1968)

Rough surface paper is best to use in printed material since it is the least subject to glare. Whatever paper is used it must be thick enough so the shadows from the print on the reverse side of the page do not show through.

(Luckeish and Moss 1941)

Paper should be as white as possible without having a glow.

(Pyke 1926)

2. Organisation

A textbook which is clearly and systematically set out will leave the student with a clear and systematic grasp of the material.

(Demilia 1968)

A well organised content displays a plan which simplifies the message.

(Taylor 1977)

As the organisation of content improves, readers understand more, learn more and remember more.

(Deese 1961)

A clear, concise title at the beginning of an article orientates the reader and helps with subsequent recall.

(Dooling and Lachman 1971)

Titles containing the fewest possible words that adequately describe the content of the text help form attention and expectations.

(Kozminsky 1977)

There are a number of ways of asking readers to do things before they start to read an article which help their subsequent understanding of the material.

Summaries, overviews, pre-tests and advance-organisers are examples of such different pre-instructional strategies.

(Hartley 1978)

Behavioural objectives are useful to serve to inform readers about what they are expected to be able to do when the instruction is over.

(Davies 1976)

Outlining the main ideas in a section before a section starts, or summarising them at the end, is beneficial.

(Ausbel and Robinson 1969)

Summaries at the start prepare readers for what is to come.

Summaries at the end restate points and reinforce learning.

(Hartley 1978)

Pre-tests alert, objectives inform, and advance organisers clarify conceptual issues.

(Hartley & Davies 1976)

Handouts enable students to see the structure of lectures in advance and ensure more accurate revision.

(Hartley and Marshall 1974)

Space in handouts and workbooks can affect note-taking practices. Increasing space between items has been shown to increase the number of words noted.

(Hartley 1976)

There is need for a review of information at the beginning and end of a handout.

(Hartley 1976)

Handouts help lecturers in that while considering the spatial requirements they must clarify what they are trying to say.

(Hartley and Marshall 1974)

3. Headings

Headings and sub-headings are useful to the reader.

(Burnhill 1970)

Headings assist readers who are looking for particular sections, but less obviously they provide an explicit structure which assists the reader in integrating the information he reads.

(Dooling and Lachman 1971)

Headings and subheadings - ranged from the left - together with a systematic use of space, convey more readily the structure of complex text.

(Hartley and Burnhill 1976)

Readers remember more from discursive text when the readings and subheadings are written in the form of questions rather than in the form of statements.

(Robinson 1961)

Questions in the text encourage readers to examine what they are reading, and to look for related facts and ideas.

(Hartley 1978)

Numbering can either help make clear to a reader the way in which sections are nested together, or enable both writer and reader to make specific reference to sections smaller than a page, where no other sub-heading is available for this purpose.

(Wright 1975)

Clear but complete title headings should be written to complement Illustrations, Tables, Graphs and Charts.

(Hartley 1978)

4. Typography

Legibility is the most important factor in the printed page. Before any significance can be attached to letters, words or meaning, they have to be received and recognised.

(Tinker 1965)

Typographic style should be consistent throughout a text.

(Hartley 1978)

Missing type forms within a passage of text slows a reader's speed.

(Tinker 1932)

With reference to type faces the only general conclusions seem to be that distinctiveness of shape is the most significant factor.

(Demilia 1968)

Type must be simple in outline. Recommended type size for general reading is between 6 and 12 point x height.

(Tinker 1965)

Sanserifed type, ie without a short finishing stroke at the top or bottom of a letter, is easier to read than serifed.

(Poulton 1969)

Lengthy passages written entirely in capital letters should be avoided, since they will be read more slowly than the same words in lower case type.

(Tinker 1965)

In text, capitals take about 12% longer to read than lower case settings.

(Tinker and Paterson 1928)

The benefits of cueing in a search task can only be realised when readers are informed and know that cueing is provided.

(Bartz 1970)

Italics should be used sparingly and only where emphasis is required.

(Paterson and Tinker 1940)

Underlining selected words improved immediate retention scores for the more able, but can slow and hinder the less able.

(Klare et al 1955)

It is important to note that the larger the type-size the fewer the number of words per given line length. Large type-sizes (and/or short line lengths) can cause problems.

It is difficult to recommend particular type-sizes without referring to specific type-faces because the different measurement systems used in typography conflict, and the designated type-size of a particular type-face does not specify the actual size of the printed image.

(Hartley et al 1975)

A good all-purpose size is 10 point type on a 12 point line to line feed. 8 point on 10 point is possibly as small as one would want to go in the design of instructional materials.

(Hartley 1978)

Type-faces to avoid are:

those with idiosyncratic designs,

those which will not withstand degradation when printed and copied.

(Hartley 1978)

Type should be set with an equal spacing between words.

(Gregory and Poulton 1970)

The legibility of printed matter is a function not only of the clarity with which the characters are printed, but also of the spacing of the material.

Word spacing should normally be no wider than the space required by a lower case letter i, that is about 0.25 of the type size.

Line spacing - the perpendicular distance from the base line of one line to the base line of the next line - should normally be greater than the specified type-size, say 1.25 of the type-size.

The relationship between word spacing and line spacing should be consistent throughout the text, otherwise the printing will appear to be moving about on the paper.

(Hartley 1978)

Legibility is impaired when the printer causes the word spacing to be changed from line to line in order to force out the lines to a fixed length ('justified text'). This practice involves keeping the right hand edge of the text straight. It is usually accompanied by the breaking and hyphenation of words at line ends in an attempt to minimise the spatial disorder brought about by the justification of the lines.

Erratic word spacing and the breaking of words at line ends is not only unnecessary but it also increases the cost of type-setting.

(Hartley and Mills 1973)

When text is required to be set unjustified, a fixed space should be specified for word spacing.

(Hartley 1978)

Unjustified settings are more legible for short lines and less able readers.

(Poulton and Gregory 1970)

Regular, uniform motor habits are more readily formed in reading short lines.

(Dearborn 1906)

The underlying structure of the text is more readily seen when paragraphs are identified by the use of line space rather than indention of the first line.

Indention impedes recognition of structure when each paragraph contains no more than a line or two of text.

(Hartley 1978)

A 2 column structure is probably better than a 3 column structure for straightforward prose printed on an A4 page. The line lengths in a 3 column structure on A4 are probably too short.

A single column structure on A4 is probably better than a 2 column structure for text which is continually broken by tables, diagrams, graphs etc, provided that paragraphs in the text are separated by a line space.

(Burnhill et al 1976)

Contrast between type and paper is an important consideration for legibility. A minimum of 34% difference in reflectance is needed.

(Poulton 1969)

The greater the degree of brightness contrast without producing glow or glare the greater the degree of legibility.

Standard black ink on white paper provides the most legible condition.

(Tinker 1965)

Most paper reflects 75-85% light.

Most ink reflects 5% light.

A brightness contrast of 70-80% between page and type is recommended for effective reading.

(Tinker 1966)

Factors which inhibit the legibility of text and graphical aids are:

'Reversed lettering', ie white letters on a black or dark background.

'Show-through', ie the appearance on the page of the image of words or lines printed on the reverse side.

(Pyke 1926)

Unprincipled variety of type-sizes and styles.

Words set at an angle to the horizontal.

(Tinker 1965)

Haphazardly-arranged lines connecting labels to reference points.

Functionless use of colour.

(Hartley 1978)

5. Clarity of Words

Capital letters should be reserved for the initial letter or letters of proper nouns, and for the first letter of a sentence or heading. Words are identified most rapidly when composed of lower case characters.

For emphasis words set in lower case bold characters are preferable to an all-capital form.

(Hartley 1978)

Emphasis given to the initial letter of a word can be more important than word shape.

(Phillips 1979)

The more the organisation of the content of a text approximates to normal, spoken language the easier the communication.

(Miller and Selfridge 1950)

Specialised terms should be kept to a minimum.

(Houghton 1968)

Familiar words are easier to understand than technical terms or complex words which mean the same thing. Writers should try to see if there are simpler ways of expressing their ideas, and they should test them out first.

(Wright and Barnard 1975)

There is an inhibiting effect in the use of less familiar words.

(Marks et al 1974)

Difficult, low-frequency words should be avoided.

(Wason and Johnson-Laird 1972)

Referring to items by familiar terms assists readers, whereas the use of less well-known or simply more cumbersome terms will hinder the reader.

(Wright 1976)

People can deal more easily with comparisons such as bigger, heavier, taller etc than with the opposite terms smaller, lighter, shorter etc.

(Clark and Card 1969)

Writers should treat pronouns with care. In particular they need to check that the referent of any pronoun used is completely unambiguous.

(Wright 1980)

Slight changes in wording can have sizeable effects on the success with which candidates answer examination questions.

(Johnstone and Cassels 1978)

When they are first introduced into a text it is helpful to print key items, new vocabulary and phrases in italics or bold type (or underline in typescript).

However, the research on such typographic cueing suggests that this often has little effect unless the reader knows in advance what the cues mean.

(Christensen and Stordahl 1955,
Coles and Foster 1975,
Rickards and August 1975)

Technical shorthand and abbreviations increase vocabulary difficulty, reading load, understanding and commitment to the text. They should always be properly explained.

If an abbreviation is introduced, several paragraphs should not elapse before the abbreviation is used or it may be forgotten.

(Wright 1976)

Difficulties and ambiguities often result from the use of abbreviations or acronyms.

(Hartley 1980)

People more easily follow an instruction 'to do something unless' than 'to not do something if'. Performance is significantly better if the instruction is fully affirmative such as 'Do something if'.

(Wright and Wilcoz 1977)

Connections such as 'except', 'but', 'or', 'if', 'unless' should be avoided.

(Jones 1966),
Davies 1977,
Wright and Barnard 1975)

Negative prefixes such as 'in, un, dis' are easier for people to deal with than negative particles like 'not'.

(Sherman 1973)

When considering words with negative characteristics readers can more quickly, easily and faster decide if x is more than y than decide if y is less than x. Less than is probably easier to deal with than not more than.

(Wright and Barnard 1975)

Generally it is best to avoid double negatives.

(Wason 1965,
Davies 1972,
Wright and Wilcoz 1976)

However, a negative may be much more emphatic than its alternative affirmative wording and can correct misconceptions. Double negatives in imperatives are actually easier to understand than single negatives.

(Wright and Barnard 1975)

6. Questions

Questions in the text encourage readers to examine what they are reading and to look for related facts and ideas.

Questions should always be clear and simple.

(Hartley 1978)

It is best to ask questions about one thing at a time.

(Wright and Barnard 1975)

Questions influence the depth of processing.

Specific questions help people to remember specific cases: higher order questions lead to the recall of generalisations which include specific cases.

(Rickards and Vesta 1974)

A question put at the start of a discourse often leads to specific learning.

Questions embedded in the text - but given after the relevant content - sometimes lead to more general learning.

(Bull 1973,
Ladas 1973)

Questions before a text provide an orientation for reading strategy. Questions after a text provide a check for the reader on how much he has assimilated.

(Wright 1977)

A question is more likely to be answered correctly if it is in the same form as the sentence in the instructions,

is: passive if the instructions are passive,
active if the instructions are active.

(Wright 1969)

People make three times as many mistakes when answering passive questions than active questions.

(Wright 1969)

7. Clarity of Structure

Writers should be aware of their potential readers' backgrounds.

(Hartley 1978)

The writer of technical information needs to keep the aims and abilities of his readers very much in mind as he writes.

(Wright 1977)

If possible write sentences in the active voice. Simple, active and affirmative sentences are generally more readily understood.

(Wright 1977)

Simple, affirmative sentences are easiest to understand. Introducing the passive or negative creates problems, either slowing the reader or causing him to make errors.

(Gough 1965),
Slobin 1966)

It is best to put requirements positively.

(Hartley 1978)

Sometimes, however, the passive voice may be used rather than the simple, active affirmative.

(Tichy 1966)

Short and simple sentences are easier to understand than long ones as they contain less information.

(Flesch 1945)

Sentences less than 20 words long are probably fine. Sentences 20-30 words long are suspect, and sentences containing over 40 words will almost certainly benefit from re-writing.

(Hartley 1980)

Sentence length should be limited to one subordinate clause.

(Hartley and Burnhill 1977)

Few sentences should have more than one subordinate clause. The more subordinate clauses there are, the more difficult it is to understand a sentence.

(Miller 1964,
Wright and Barnard 1975)

It is desirable to have the first clause as the main rather than the subordinate clause.

(Clark and Clark 1968)

Clauses should not be embedded,

is one clause merging and interrupting another.

Changing a long clause into two shorter co-ordinate clauses can be worthwhile.

(Jones 1968)

It is easier to process a sentence when the sequence of events mentioned in the sentence corresponds to their temporal order.

(Clark 1971,
Flores d'Arcais 1976)

Readers often expect that important information should be given at the beginning and ends of paragraphs.

(Van Dijk 1977)

Dull or unnecessarily complex text is a definite determinant of mental fatigue.

(Demilia 1968)

Topic Oriented Writing:

focuses on generalisations and concepts which constitute a body of knowledge, ie about a subject area, not what to do or how to do it. It does not identify a particular user audience.

Performance Oriented Writing:

focuses on the duties and tasks a user is expected to perform and the information he needs to perform particular duties and tasks. It identifies a particular user audience.

Performance oriented writing is more effective than Topic or Subject oriented writing.

Writing in a Topic or Subject oriented approach provides difficulties such as:

material is just a body of knowledge,
material is often too general and unspecific,
material only deals with the subject area,
material lacks adequate organisation and preparation,
material is not directed to the user.

Faults in such writing have been found in the following areas:

Long sentences	Not direct enough
Confusion of material	Dull and uninteresting text
Run-together format	Too vague and wordy
Weak visual aids	Remote references.

A performance oriented approach is geared more to the reader.

(Kern, Sticht, Welty
and Hauke 1976)

Textbook writers often adopt a formal, impersonal style when a friendly, personal approach would be more helpful to the reader.

(Jenkins 1976)

A text which keeps talking about the same few things is easier to follow than a text which deals with a variety of different topics.

(Kintsch et al 1975)

8. Complex Material

Written instructions are often presented in ways that are difficult for a reader to follow, understand and remember.

(Chapanis 1965)

There is no universally optimal way of presenting complex information.

(Wright and Reid 1973)

Presenting technical information often involves a special set of problems, since readers probably lack knowledge of detailed technical terms and relations essential to the material and a grasp of fundamental concepts.

(Wright 1976)

Readers can read and answer questions more quickly from highly technical text when it is 'chunked' into meaningful elements.

(Frase and Schwartz 1979)

'Information mapping' is a method of organising categories of information and for displaying them in diagrammatic form, both for learning and reference purposes. The emphasis is on organising formats which communicate quickly and which facilitate scanning and retrieval.

(Horne 1969, 1974)

Complex instructions and material are often difficult to understand when set out in prose form. Flow charts can reduce the likelihood of the reader making errors as they help the reader to structure his problem. Flow charts ensure that all relevant factors are taken into account. However, they are more cumbersome to produce than Decision tables and are slower to use.

(Wright 1971)

Although Flow charts or Decision tables may be more effective than prose, the optimal format depends upon the topic and the conditions of use.

Using short sentences may be preferable to using a Flow chart or Tabulation scheme if the reader must remember what he reads.

(Wright and Reid 1973)

It has been suggested that Flow charts are perhaps best for sorting out complex information, Tables when presenting complex information, but that linked statements are best if the material has to be remembered.

(Davies 1972,
Wright and Reid 1973,
Blaiwes 1974)

The reader must know in advance how to read a Flow chart or Table. Many do not.

(Hartley 1978)

Omitting relative pronouns, eg which, that, who, from sentences saves space at the cost of comprehension.

(Haker and Foss 1970)

People take longer to read sentences having more prepositions even though the sentences have roughly the same amount of words.

(Kintsch and Keenan 1973)

Care is necessary when trying to simplify texts which need to be complex to convey the meaning properly. 'Amateur surgery' can kill the meaning rather than expose it.

(Flesch 1951,
Klare 1971)

The more material a writer can place in appendices the better - but there is a risk that readers will not consider it important.

(Tichy 1966)

9. Illustrations

Illustrations serve two separate purposes in instructional text:

They can support the text and help make information much easier to understand.

They can help motivate the reader.

(Davies 1971)

Illustrations serve: to motivate the reader
to aid explanation
to sustain long-term recall.

(Duchastel 1978)

Illustrations are often more efficient than prose at conveying complex information and summarising discriminations, concepts and principles.

They are especially useful for less-able readers.

(Davies 1971)

Good diagrams: are relevant and accurate,
are restricted to be easily comprehensible and understood,
reveal the processes they represent,
are responsive to manipulation,
are readily and easily revisable.

(Fitter and Green 1979)

The use of illustrations and appropriate simple labelling may be a convenient way of avoiding technical terms.

(Wright 1975)

Simple drawings should be used for simple objects.

(Wright 1975)

The interpretation of cross-sectional or flow-process diagrams can cause problems to readers.

(Davies 1971)

Third angle orthographic projections are less suitable for simple flat surface assemblies than representational projections.

However, with assemblies involving compound curved surfaces these orthographic projections result in better performance.

(Spencer 1973)

In technical drawings the use of reference letters and a legend has been found to be more beneficial than trying to label dimensions on the actual drawing.

(Spencer 1973)

Illustrations should fit at the appropriate point in the correct sequence to their associated text. They should never be a page turn-over from their text.

(Whalley and Fleming 1975)

Pictographs are iconic symbols which may be used as illustrations. However, there are difficulties.

They could be open to misinterpretation, and there are problems in showing fractions of a unit.

(Wright 1977)

There is need to test the effectiveness of illustrations as well as the language of text.

(Godwin 1977)

Maps are exceptionally complex visual displays. Names of places should be set in a typeface of normal weight in lower case with an initial capital letter. However, when names are very difficult to pronounce and need to be copies accurately, all capitals are recommended.

(Phillips, Noyer and Audley 1977)

Searching maps for straight rather than curved names is faster.

(Poulton 1972)

To choose the optimum format for a particular occasion one has to consider, amongst other things:

the kind of data being shown,
the teaching points being made,
what the learners are required to do with the data presented to them.

(Macdonald-Ross 1977)

10. Colour

Colour serves two separate purposes in instructional text:

It can help make information much easier to understand.
It can help motivate the reader.

Using colour as a typographic cue is often unnecessary. Excessive use of colour can cause problems for the reader.

Colour should be used sparingly and consistently, and its function explained to the learner.

No colour has the contrast value of black on white.

(Hartley 1978)

It is worth remembering that about 8.5% of males and 0.5% of females are colour blind to some extent.

Colour needs to be tested before use. A pale colour judged over a large area may prove invisible for a word or line.

A dark colour may appear black for a word or line. Bright colours may dazzle the reader.

Colour must remain true under all types of lighting.

(Hartley 1978)

Patches of coloured background may be used within a text to indicate material which may either be skipped or which requires being attended to in a different way from the majority of the text.

(Haber and Fried 1975)

When subjects knew the colour of a name on a map, ie black for land, blue for water, search times were faster than in the case of a map where all the names were printed in black. When subjects did not know the colour of the name in question a single colour name on the map was faster.

(Foster and Kirland 1971)

11. Figures

When presenting numerical data, prose descriptions often seem less off-putting than the actual numbers. Everyday words which act as rough quantifiers, eg 'nearly half the group', are adequate for most purposes and seem to be handled with reasonable consistency by different people.

(Hammerton 1976)

Verbal descriptions of probabilities are less off-putting for many people than the actual figures. However, the interpretation of a verbal description of probability seems to be less consistent than that of quantity.

(Cohen 1960)

The following phrases may be used confidently with adult readers:

Numerical value to be conveyed	Suitable phrases
above 85%	almost all of...
60%-75%	rather more than half of...
40%-50%	nearly half of...
15%-35%	a part of...
under 10%	a very small part of...

(Godwin, Thomas and Hartley 1977)

If precision is required, then actual quantities may be given with the verbal quantifier, eg one can say 'nearly half the group - 43% - said...'.

(Hartley 1978)

Arabic numerals are preferable to Roman numerals.

(Perry 1952)

Standard or Ranging numerals align better than Non Standard in mathematical text.

(Hartley 1978)

Digits are generally easier to remember than letters except when confenient mnemonics exist for letters.

(Jacobs 1887)

People more easily remember a given number of digits than alpha-numeric characters.

(Conrad and Hull 1967)

Breaking long digit sequences into smaller groupings of, say, 3 items, eases retention.

(Adams 1915)

It is easier to remember the code when letters and digits form separate groups, eg 111 ddd.

(Byrne and Campion 1972)

If letters and digits have to be mixed then a regular pattern, eg dd l dd l is easier for people than when successive groups have a different pattern.

(Broadbent and Broadbent 1973)

12. Tables

Tables can communicate information quickly and clearly.

(Davies 1971)

Tables vary in complexity and function, eg from a calendar to a logarithm table.

In the presentation of a complex table there must be a full and direct presentation of all the information a user will need.

The reader should not have to work out an answer from the figures provided.

(Wright and Fox 1972)

Digital tabulation is better than analog presentation for giving precise information. It removes some of the hazards of leaving interpolation to the user.

(Hartley 1978)

When readers know which are the internal parameters they will more rapidly select the material which meets these constraints by consulting a table.

(Wright and Reid 1973)

Having only one choice along each axis is faster to use than where two binary choices are made on each axis.

(Wright 1976)

With complex tables it is helpful to have:

items arranged so that they are scanned vertically rather than horizontally,

appropriate spacing within and between columns, ie with related pairs closer than unrelated ones.

(Wright 1968,
Wright and Fox 1972)

If the columns in a table are lengthy then use regular line spacing (about every 5 items) as this helps retrieval.

(Wright 1968),
Wright and Fox 1972)

If the table is wide and contains many columns, then place row headings both to the left and to the right to help comprehension.

(Wright 1968,
Wright and Fox 1972)

If there are many rows and columns, then number or letter headings. However, if possible, avoid the use of numerous columns and rows and consequent footnotes.

(Wright 1968,
Wright and Fox 1972)

Tables can be designed to present information clearly without the need for printers' 'rules'. Horizontal rules can be used to help group information, but they should be used sparingly.

(Burnhill et al 1975)

Left - ranging tables

ie tables in which items are not centred over one another but range from the left-hand margin, are easier to construct and quicker to type and to typeset.

Such tables are no less comprehensible than tables arranged in the centred style.

(Burnhill et al 1975)

People who were searching for items in a list found the items faster when the list was subdivided into familiar categories of words rather than a single, alphabetical list.

(Barnard, Morton, Long and
Ottley 1977)

Tables separated from their associated textual reference may cause the reader to lose track of an argument. The same is probably true for graphs and illustrations.

Text matter and related illustrations should be consistently positioned relative to one another rather than 'balanced' for aesthetic effect.

(Whalley and Fleming 1975,
Burnhill et al 1976)

Most statistical tables are badly presented and understanding them requires a great deal of effort. The criterion for a good table is that patterns and exceptions should be obvious at a glance. There are 4 basic rules of data presentation:

Drastically round numbers so that readers can easily make meaningful comparisons.

Include averages as they not only summarise data but allow one to grasp the spread between the above-average and below-average values.

Figures in columns are easier to compare than figures in rows.

Order rows and/or columns by size. Large numbers at the top help mental arithmetic. Ordering by size aids comparison.

(Ehrenberg 1977)

13. Graphs

Graphs - like Tables - have many different functions.

The simplest kinds of graphs, and the easiest to understand, are Line Graphs and Bar Charts.

(Schutz 1961,
Feliciano et al 1963)

Labelling lines on a graph directly is likely to be much quicker and more helpful than referring the reader to a legend elsewhere.

(Milroy and Poulton 1978)

Both vertical and horizontal axes should be lettered horizontally.

Repeating the x and y axes on the top and right hand sides respectively of a graph increases the ease with which extreme points on the graph can be read.

(Hartley 1978)

If the aim of a graph is to compare different conditions, then several lines can be plotted on the same graph. However, a large number of lines can be confusing, and it is probably best to separate them by typographic cues, eg different symbols, or to use separate graphs.

(Schutz 1961)

It may be advantageous to break graphs down into smaller units rather than have too much information presented on a single graph.

(Goodman 1953)

Understanding of graphs is improved if there is a textual discussion of results.

(Hartley 1978)

14. Charts

When the task of the reader is to estimate percentages and quantities, Bar Charts are a better method of presentation than are cross-sectional drawings of three-dimensional objects such as spheres, cubes, and blocks of columns.

(Dickinson 1973,
Hawkins et al 1975)

Bar Charts are most effective when simple. They can be subdivided, eg a score can be shown as a composite of a number of different subscores, but such compound Bar Charts can be confusing.

(Croxton and Stryker 1929, Hawkins et al 1975)

Pie Charts are said to be easy to understand, but they can be misleading. It is difficult to judge proportions accurately when segments are small, and it is also difficult to put in the lettering.

(Croxton and Stryker 1929)

Pie Charts give a general impression of quantitative relationship, but subtle differences are more difficult to detect compared with Bar Charts.

This is because Bar Charts are based on multiples of a square module or a regular unit of two-dimensional space.

Pie Charts are also difficult to understand if charts with different diameters are being compared.

(Hawkins et al 1975)

No one format in graphic materials is universally superior to any other but some are so unsatisfactory that they should no longer be used. To choose the optimum format for a particular occasion one has to consider, amongst other things:

the kind of data being shown,
the teaching points being made,
what the learners are required to do with the data presented to them.

(Macdonald-Ross 1977)

15. Reading Conditions

There is need to appreciate the situation in which text is to be read.

(Canning, Jarman and Myke 1977)

The best reading distance is for page and eyes to be within a range of 10 to 18". The preferred distance is usually 14".

The printed page is read most effectively when on a plane perpendicular to the line of sight.

(Tinker 1965)

Lighting should be adequate for reading. Poor lighting can lead to reduced reading speed, eye strain and visual fatigue as small details are not sufficiently visible. Lighting level depends on factors like print size and brightness contrast/reflection of print and paper.

The following scales present an approximate guide to recommended light levels:

	fc	Lux
Casual reading	15-20	150-200
General Classroom or Office reading	20-30	200-300
Sustained study	25-35	250-350
Maintenance	40-100	400-1000

A Footcandle (fc) is the light intensity upon a surface perpendicular to the light rays from a standard candle at a distance of 1 foot.

(Tinker 1965)

The 'brightness ratio', ie the relationship between the brightness of two adjacent areas such as a page and desk top is important. The ideal condition is equal brightness 1:1.

If the surrounding area is brighter than the book visual sensitivity is reduced.

The most common condition is when the page is brighter than the surrounding area. A ratio of 3:1 is acceptable but beyond 5:1 visual sensitivity is impaired.

(Tinker 1965)

The best temperature conditions for reading are between 60-65^{o}F with good ventilation.

(Tinker 1965)

If air temperature is 27^{o}C or 80^{o}F there is reduced reading speed and comprehension.

Noise has a detrimental effect on reading ability.

(Bronzcroft and McCarthy 1975)

Vibration of text - 0.02" at 19 Hertz - can cause increased errors and reduced reading speed as it blurs the images on the retina of the eye.

(Dennis 1965)

Increasing vibration frequency and displacement causes greater errors and time taken in reading.

(Meddick and Griffin 1976)

The motion of the reader can cause problems. Subjects adding columns of numbers at up to 0.3 G at 0.3 Hertz proved poor because of motion sickness.

(Brand, Colquohoun, Gould and Perry 1967)

16. General Points

None of the factors affecting the printed page exist in isolation.

(Demilia 1978)

Although no one single factor may have a significant effect on reading and learning a number of factors combined can reduce reading efficiency.

Instructions in a manual need to be checked for agreement with what actually happens.

(Godwin 1977)

The provision of mnemonic retrieval cues, eg recognisable abbreviations or contractions, can improve memorability of information.

(Lindsay and Norman 1972)

Readers will pause longer at material thought relevant to a subsequent quiz or test than other material.

(Rothkopf and Billington 1978)

The most effective coding systems for highly structured information such as bibliographic material are those which:

make a clear distinction between successive entries, such as by indentation, and

make a clear distinction between the first word of each entry and the rest of the entry.

(Spencer, Reynolds and Coe 1974)

Guidelines such as those reported in this paper should not be considered as dogma to be followed, but rather as ideas to be considered when preparing instructional text. Guidelines make general statements which must be treated with caution when applied to specific problems.

There is, however, one overall guideline which is applicable to all instructional text. That is that initial versions need to be tried out with samples of the target population for when they are intended, and revised on the basis of results obtained.

(Hartley 1977)

APPENDIX G

OUTLINE OF A PROPOSED WRITER'S PRODUCTION CHECKLIST OR JOB AID

✓ or X

1. Is your type clear, simple and consistent?
2. Have you used lower case mostly?
3. Have you used unjustified text and not 'broken' words at the end of lines?
4. Have you used line spacing rather than indentation to identify paragraphs?
5. Is there enough contrast between type and paper?
6. Have you provided clear titles and considered objectives, advance-organisers, overviews, summaries?
7. Have you put in appropriate headings?
8. Have you set out material clearly and systematically?
9. Have you put material in a logical sequence?
10. Have you added questions where suitable?
11. Have you used simple, direct, active, informal and familiar language where possible?
12. Have you avoided unnecessary words, kept specialised terms to a minimum and explained them when they are necessary?
13. Have you explained abbreviations and acronyms?
14. Have you kept sentences and paragraphs short and concise?
15. Have you used illustrations where they can help?
16. Have you kept illustrations as simple and effective as possible?
17. Have you put illustrations next to associated text?
18. Have you used colour properly?
19. Have you fully considered the kind of data being shown, the points to be made, what learners are expected to do with the information?

20. Have you fully considered your readers' experience, ability and possible problems with the text?

21. Have you properly appreciated the context and situation in which your reader will use the text?

22. Have you used as much variety and interest as possible?

23. Have you considered using strategies like flow charts, decision tables, mnemonics etc to help better understanding and learning of material?

24. Have you checked your first draft content independently and with other writers?

25. Have you checked your draft for presentation method

    with: Readability formula, a 'Transformer'

    on: potential readers by test and discussion?

APPENDIX H

INSTRUCTIONS FOR USING CLOZE PROCEDURE AND FORCAST READING DIFFICULTY LEVEL FORMULA

In both cases writing should be directed to the reader or user. The procedure or formula serve as a guide for the reading difficulty of material which has already been written.

(a) Cloze Procedure

(i) Delete a number of words randomly determined or at fixed intervals, commonly every fifth word.

(ii) In place of the words removed, underline equal size gaps.

(iii) Readers are asked to complete the passage and the number of correct responses scored.

The degree of successful replacement of deleted words gives a measure of how well the remaining words provide an appropriate context for aiding the reader.

If the reader can supply verbatim responses this probably indicates that writer and reader have sufficient commonality in the text for it to convey accurately the writer's meaning to the reader.

(iv) A correct response of 40% tends to correlate with a reader being able to effectively gain information from a text.

In contrasting passages those on which higher scores are obtained may be regarded as more readable.

(b) Forcast Reading Difficulty Level Formula

(i) Select a 150 word passage which should preferably be a complete paragraph or section. Words include numbers, letters, symbols and groups of letters that are surrounded by white space. Hyphenated words are counted as one word.

Count syllables the way the word is pronounced.

(ii) Divide the number of one syllable words by 10.

(iii) Subtract the result from 20 to obtain the US reading grade level.

(iv) Add 5 to give the proposed reading age of UK readers.

(v) Repeat for several 150 word passages.

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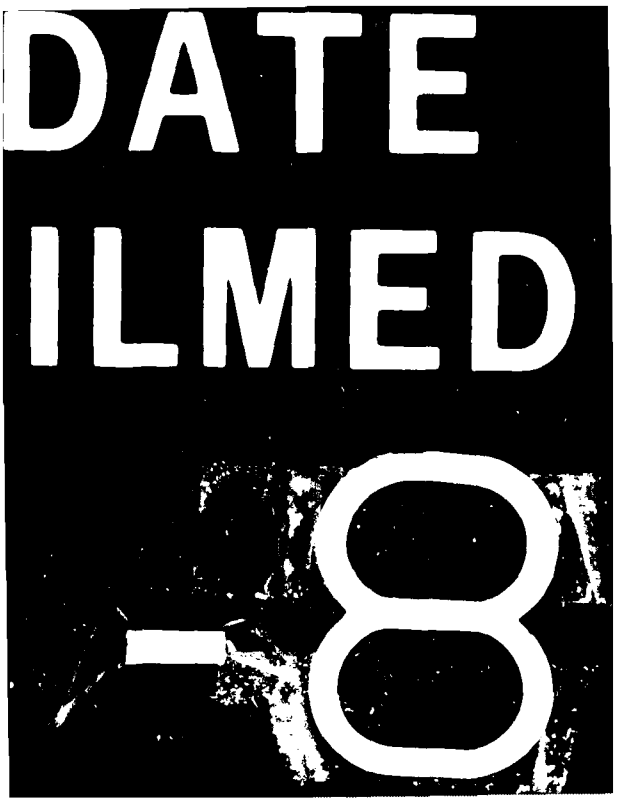
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